The Impact of Blue Swimming Crab Fishery Management on the Profitability of US Buyers

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ABBREVIATIONS

BSC   Blue swimming crab

CHN   China

CPT   Cost pass-through

CPUE   Catch per unit effort

FIMM   Full Industrial Market Model

HHI   Herfindahl Index

IDN   Indonesia

IND   India

NFI CC   National Fisheries Institute Crab Council

PHP   Philippines

SEA   Southeast Asia

THA   Thailand

VTN   Vietnam

EXECUTIVE SUMMARY

Background: recent trends in blue swimming crab imports from Southeast Asia

In the past decade, the US market has experienced volatility in import quantities and prices of blue swimming crab (BSC) from Southeast Asia. Import volumes decreased from 47 million lbs in 2007 to 41 million lbs in 2017, a reduction of 13%. Import prices increased between 2010 and 2017 from $8.21/lb to $11.32/lb[1], an increase of 38%. Price volatility has increased over the past five years, with impacts on the profitability of the US firms engaged in buying BSC from Southeast Asian countries.

This volatility in import volumes and prices is partly driven by unsustainable fishing practices. According to interviews with industry members of the Crab Council, weak management of crab fisheries in Southeast Asia is one of the key drivers of volatility in crab production costs. Other drivers of volatility include fluctuations in currency exchange rates and swings in demand for the crab meat. When the BSC stock declines, the crab become scarcer and fishers must put more effort into landing a kilo of crab. That is, catch per unit effort (CPUE) decreases, leading to increased prices at the quayside, which propagate along the supply chain. At the same time, the spread in price between meat from large, mature crab and smaller crab has widened by 23% in ten years, with Claw-Jumbo spread jumping from $14.25/lb in 2007 to $17.59/lb in 2017. This is consistent with a squeeze on mature crab supply, a sign of over-fishing, as individuals are caught before they reach full size.

Importers

The US import market is highly fragmented: there are a few large firms and a large number of medium and small firms. Five large firms, with market shares between 5% and 20%, account for half of the import market. Around 42 small and medium-sized firms account for the other half, 25 of which have market shares below 1%.

Firms differ in their gross margins, ranging from low single digits to above 20%. Higher margins reduce the firms' vulnerability to import cost shocks. Firms with higher margins may absorb increases in import prices and remain in the market, while in contrast, vulnerable, lower margin firms may even be forced to exit when cost shocks occur.

Firms also vary in their geographical pattern of crab sourcing, leaving more diversified firms less exposed to cost shocks. Diversification of import sources pools risks, so larger firms, which have the capacity to diversify, tend to adopt this strategy. In contrast, over 70% of small firms source from only one country, exposing them to cost shocks from currency movements and over-fishing.

Cost shocks originate from a number of causes, including fishery stock declines. If mortality of fish in the stock exceeds recruitment, commonly as a result of over-fishing, the stock declines. These declines in stock can be very rapid. In response, catching costs rise rapidly as the catch per unit effort falls, and buyers experience a cost shock.

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[1]Prices quoted throughout the report are real (inflation adjusted) 2017 US dollars.

Firms sourcing from countries with a larger share of production are less exposed to import price shocks. Firms sourcing from countries that produce a large portion of supply, such as Indonesia, find changes in their costs passed through to retailers at a higher rate. In general, the greater part of the (import) market that is shocked, the larger fraction of costs that are passed through. When countries with a large share of the market experience cost increases, the importers of product from those countries find that the costs are passed through to the retailers. Whereas, when countries with a smaller share of the market, such as Thailand, experience cost increases, wholesale prices adjust little, as most product is sourced elsewhere and is not affected. Thus, firms importing from countries with large fisheries are able to pass on more of their costs to retailers, when costs increase.

Indonesia, China and the Philippines are the largest sellers of BSC to the US. In 2017, imports to the US from Indonesia constituted 46% of the supply, followed by China, 18%, and the Philippines with 16% of supply. The balance of supply is made up by Vietnam, Thailand, Sri Lanka, and India. The imports from China include red swimming crab, which is a partial but inferior substitute for blue swimming crab.

Impacts of increases in import costs

Import prices have typically varied by about 15% around a mean. A modelled shock of this magnitude affects the US import market substantially. Margins and market shares of firms that are vulnerable might fall dramatically when faced with an import price increase. This is because most firms will absorb the greater part of a cost increase, passing on the smaller part to their customers. The rate at which they can pass through costs to the retailers varies by the crab's country of origin. Countries of origin with smaller relative share of the market, such as Thailand and Vietnam, offer cost pass-through rates below 10%. Meanwhile, the highest expected cost pass-through rate estimate is for Indonesia, 29%-38%.

The impact on margins and market shares also depends on the diversification strategy of the firms. The study shows that firms with diversified countries of origin are better able to withstand individual country cost shocks.

Conclusions

The analysis shows how over-exploitation, which generates cost increases for fishers, is passed down the supply chain with severe adverse effects on the profitability of firms, in this case, illustrated for importers. Almost all small- and medium-sized firms importing BSC from SEA into the US would be expected to lose nearly all of their margin and market share when import prices increase. Large undiversified firms, accounting for 19% of the market, would be expected to lose between 32% and 47% of their margins and between 21% and 38% of their market share.

Firms can mitigate some of the negative impacts in the short term by reducing their exposure and vulnerability to cost shocks. Firms can invest in geographical diversity of sourcing crab and can weight purchasing towards countries with larger cost pass-through rates. Firms may also make themselves stronger by merging, if by so doing they increase their margins. Both strategies have already been adopted by some firms in the past, while others might lack the resources to adapt. Interview evidence indicates that firms also use pricing and inventory management measures such as variable pricing contracts, shorter contracts and last-in pricing contracts with retailers to mitigate price volatility risk. While these strategies may cushion shocks in the short term, firms may still experience negative financial impacts. Action towards improving the health of the BSC stock in Southeast Asia remains necessary to address effects on profitability.

Although there are strategies the firms can adopt to limit the damage to their bottom line, only a collective effort, harnessing the power of both industry and government, can address the root cause and prevent the status quo from getting worse. In the absence of government policies, action by the National Fisheries Institute Crab Council (NFI CC) could reduce volatility in source countries. For example, enforced crab meat grade standardization could reduce the catching of undersized crab (Wilderness Markets, 2018), improving the health of the fisheries. Since the Crab Council members account for around 70% of the disclosed US blue swimming crab imports, continued industry-led action could be effective.

However, better management of the fisheries in supply countries is needed in the long term. Higher biomass offers higher cost per unit effort (CPUE) for fishers, reducing harvesting costs and volatility in costs. Firms can support investment in fisheries management to reduce risk to themselves. The returns from improving fishery management will be highest in the lower-volume producing countries, as their cost pass-through rates are lower. Similarly, countries with many small exporting firms, which are most vulnerable, may expect higher returns from improving fishery management.

Similar results are likely in other fisheries, differing to some degree according to the behavior of the fish stock and the market structure. The evidence of trend increases in costs and declines in volumes, together with volatility in both volumes and prices, is typical of poorly-managed, over-exploited fisheries. The negative consequences for firms in the supply chain, and particularly for small and less-diversified firms, are highly material and adverse. It is likely that they are commonplace across poorly-managed, over-exploited fisheries.

1 INTRODUCTION

Assessing the impact of volatility in supply of blue swimming crab in Southeast Asia on profitability of buyers in the US

1.1 Objectives

This project was commissioned by World Wildlife Fund (WWF) US and funded by the Gordon and Betty Moore Foundation under the Ocean and Seafood Markets Initiative (OSMI). It aims to demonstrate the negative impacts of unsustainably managed fishery resources on seafood buyers and suppliers, using the blue swimming crab (BSC) market in the US as a test case. It intends to examine the financial consequences to importers in order to demonstrate the value of sustainable fishing practices to those participating in the supply chain.

1.2 Background

In the past decade, the US market for BSC has experienced volatility in import quantities and prices. Import volumes have been decreasing and import prices have been increasing. Price volatility has increased over the past five years.

This volatility in import volumes and prices is partly driven by unsustainable fishing practices. Although the data is unable to statistically test the relationship between unsustainable fishery management and price and quantity volatility, stakeholders have indicated that, in addition to changes in currency exchange rates and changes in demand for crab meat, unsustainable management of crab fisheries in Southeast Asia (SEA) is driving volatility in costs. At the same time, the spread in price between meat from large, mature crab and smaller crab has widened, consistent with a squeeze on mature crab supply, a sign of over-fishing.

Volatility in import prices impacts the profitability of the US firms engaged in the buying and selling of the product from SEA countries. Importers face reduced margins and potentially lower market shares when their costs increase. When cost increases exceed the margin of importers, and cannot be fully passed through to customers, they are potentially at risk of financial distress.

1.3 Approach

This report explores the effect of import price increases for the SEA BSC fishery on US buyers. The impacts on margins, market structure and composition are simulated using Vivid Economics' in-house Full Industrial Market Model (FIMM). The set up and calibration of the model are informed by interviews with stakeholders of the BSC industry.

The modelled cost shock is a continuation of historic volatility in import prices. The percentage increases in costs for importers are informed by historic cost increases of BSC imports from SEA. In the scenarios, individual countries and combinations of countries in SEA are subject to a cost shock. Due to the lack of data on stock health, no assumptions on the origin of these cost shocks are made, though, as indicated above, they would be consistent with deterioration of stock levels.

1.4 Structure

The remainder of this report is structured as follows:

— Section 2 describes the current state of the BSC fishery and import market;

— Section 3 presents the key results of the model estimating cost pass-through, out-turn market share and profitability of firms under various cost shock scenarios, testing the sensitivity of these results to the model assumptions;

— Section 4 draws conclusions for fishery management and the industry on the benefits of improving the state of the BSC fisheries and how to mitigate risks.

2 CURRENT STATE OF THE US BLUE SWIMMING CRAB

A fragmented market with a few large firms and a large number of small and medium-sized firms

2.1 Market structure

The US import market for BSC is highly segmented by size. The data indicate that, in total, 47 firms import BSC into the US[2]. There are five large firms having a market share of over 5% each, constituting more than 50% of the market. The largest firm constitutes over 20% of the imports. Around 42 small and medium-sized firms account for the other half of the market, 25 of these firms having market shares of less than 1%. Figure 1 depicts the distribution of market shares.

*Figure 1.* Supply is segmented: a few large firms and many small and medium-sized firms
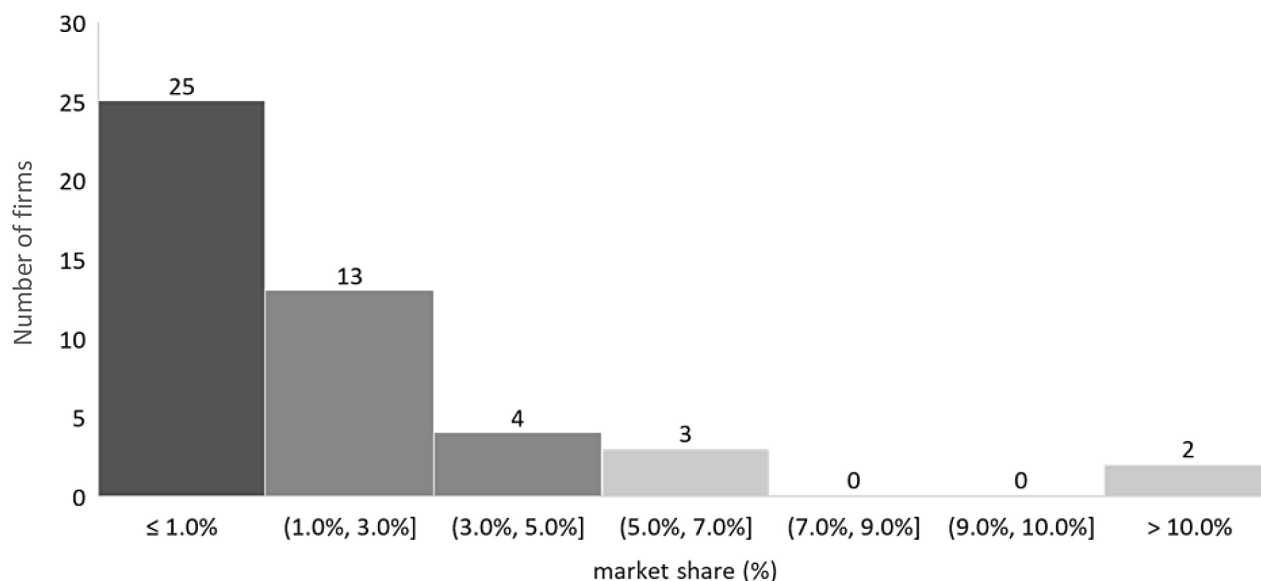
Source: Vivid Economics based on Urner Barry data

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[2] The Urner Barry data does not identify BSC importers since firms operate under a variety of names and do not always label imports by species. Interviews with stakeholders helped to identify which firms are BSC importers.

Gross margins for firms in an average year are expected to range from low single digits to 25%. The model has been calibrated to a maximum gross margin of 25%, informed by stakeholder interviews. Figure 2 shows the range of margins by firm size. Small firms have margins well below 5%, making them most vulnerable to cost shocks. Medium firms have margins between 5% and 11%, while large firms have margins from 13% up to 25%. Higher margins reduce the firms' vulnerability to import cost shocks. Firms with higher margins are able to absorb increases in import prices and remain in the market, while lower margin firms are vulnerable and may even be threatened with exit when cost shocks occur.

Figure 2. A wide range of margins for small, medium and large firms
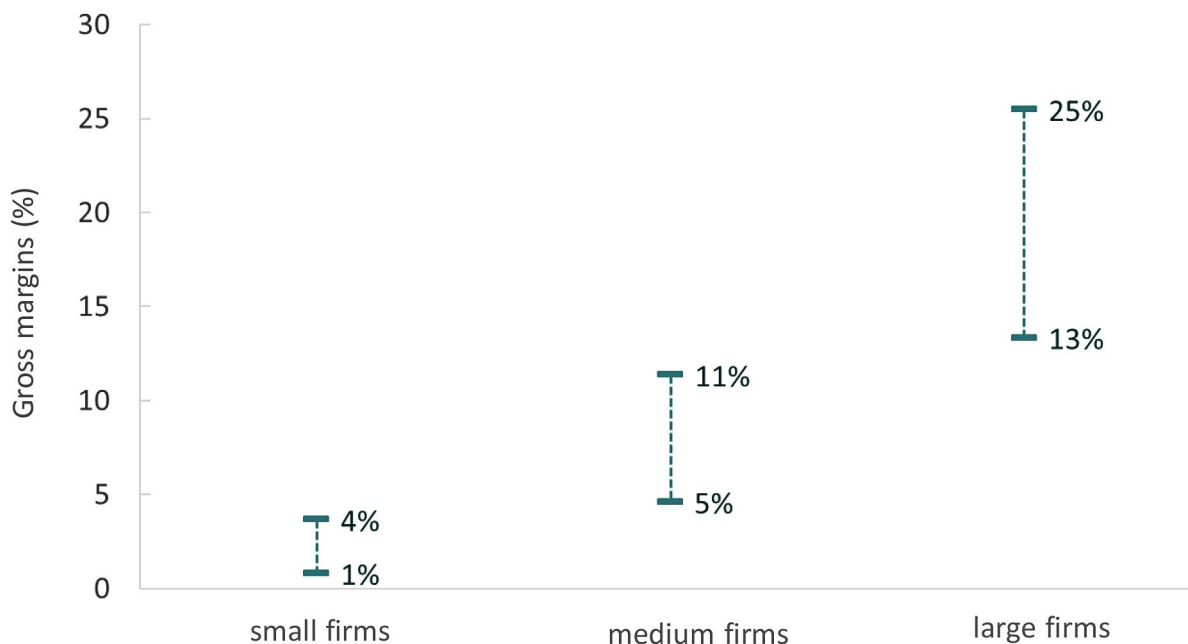
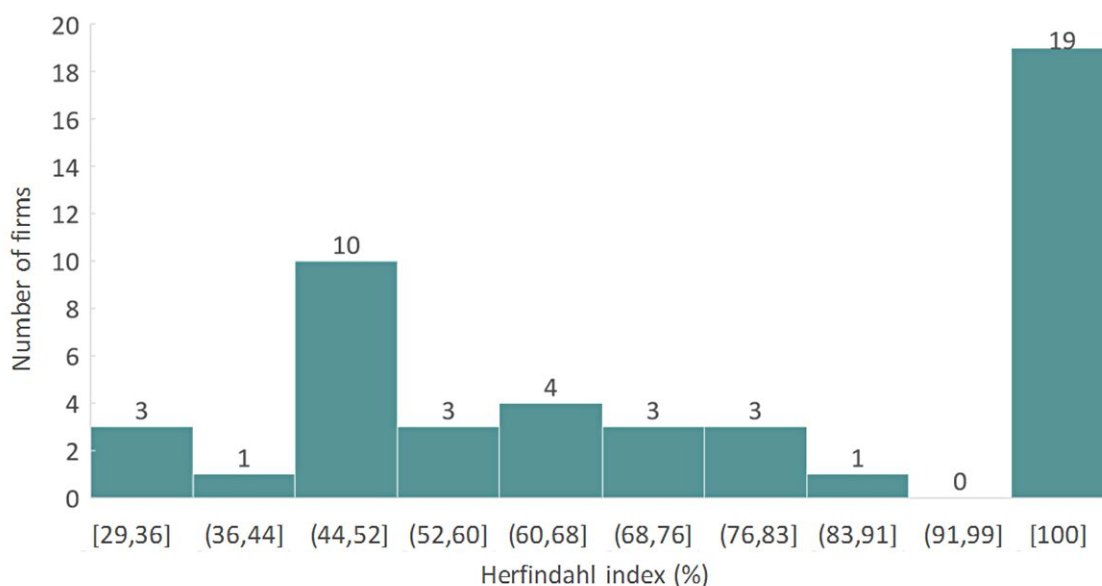*Note:* Margins based on model calibration, weighted average margin of 13.8%
Source: Vivid Economics

The level of diversification in import sourcing by individual firms varies but is low for small firms. The sourcing strategy of medium-sized firms resembles that of small firms. The Herfindahl index (HHI) indicates diversification[3]; its distribution across all firms is shown in Figure 3, which shows that 40% of firms only source from one country, of which only one is a medium firm and one is a large firm. The other large and medium-sized firms are more diversified. The average HHI is 85% for small, 59% for medium and 50% for large firms. The lower the index number, the greater the diversification. A firm sourcing exactly as the average market displayed in Figure 4 (that is 46% from Indonesia, 16% from the Philippines and so on) would have a HHI of 28%. Large firms source 90% of their imports from SEA countries and around 10% from China and India. In contrast, small firms source 69% from SEA and 31% from China.

Figure 3. Herfindahl index for US importers

The level of diversification affects a firm's exposure to cost shocks. Diversification of import sources spreads risks, so larger firms, with the capacity to diversify, tend to adopt this strategy. A cost shock in only one source country affects undiversified firms more substantially (if they source from that country) as a larger share of their imports face a cost increase.

Around three-quarters of US imports are from SEA, with Indonesia being the principal country of origin. Figure 4 shows imports to the US in 2017 by country. Indonesia supplies around 21 million lbs of BSC imports, almost half of the market. China is the second largest supplier (8m lbs), of which a proportion might be red swimming crab, followed by the Philippines (7m lbs). All other countries contribute less than 10% each. Approximately 99% of the content is pasteurized and chilled crabmeat (Wilderness Markets, 2015).

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[3] The Herfindahl index is calculated as the sum of the square of the market share of the countries that a firm imports from . The higher the index the less diversified a firm is, with a maximum of 100% if a firm sources from a single country. If a firm sources from all countries equally, its HHI would be 14%.

Figure 4. Around three-quarters of US imports in 2017 are from Southeast Asia
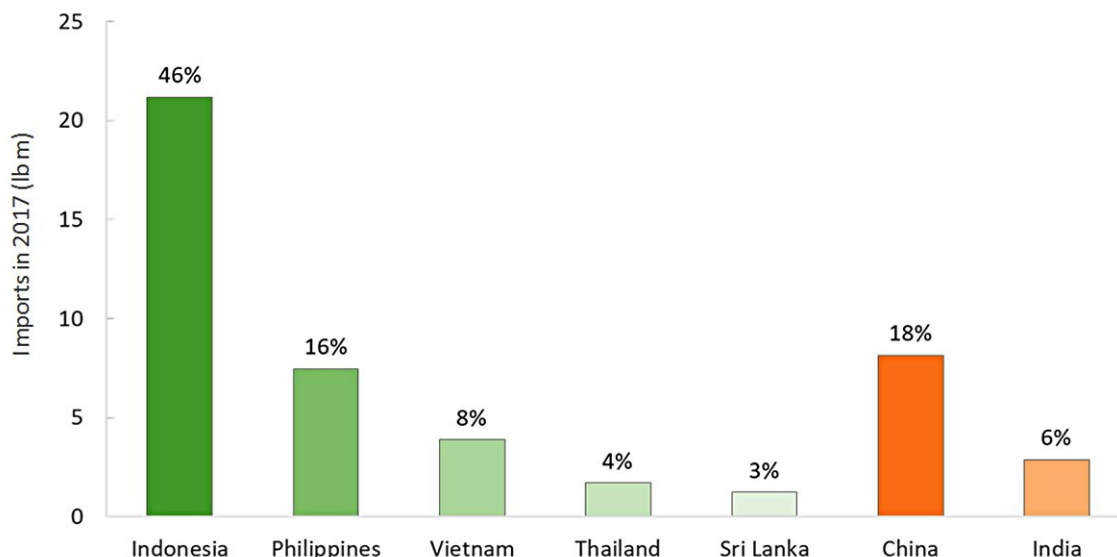
Note: Data labels show market shares
Source: Vivid Economics based on Urner Barry data

Firms have already adopted certain measures to mitigate the negative impacts of volatility. Interview evidence suggests that some larger firms have diversified their sourcing in the past years, both in terms of countries as well as vendors they buy from. Firms also use pricing and inventory management measures such as variable pricing contracts, shorter contracts and last-in pricing contracts with retailers to mitigate price volatility risks. Nevertheless, some small firms have been reported to exit the market in years when import prices are high and they or others re-enter when the prices fall, demonstrating their high vulnerability.

2.2 Trends in prices and quantities

The US market for BSC has experienced volatility in import prices and quantities.

Import quantities have declined over the past decade. The volume of BSC imported decreased from 47 million lbs in 2007 to 41 million lbs in 2017, a reduction of 13%, which is an arithmetic average of 1.3% per year. The annual quantities have fluctuated around this general declining trend (see Figure 5).

Import prices have risen over the past decade. The average declared price per pound imported from Indonesia rose between 2010 and 2017 from $8.21/lb to $11.32/lb, an increase of 38%. Price volatility has widened in the last five years (see Figure 5).

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Figure 5. *The US market has experienced volatility in import quantities and import prices over the last decade*
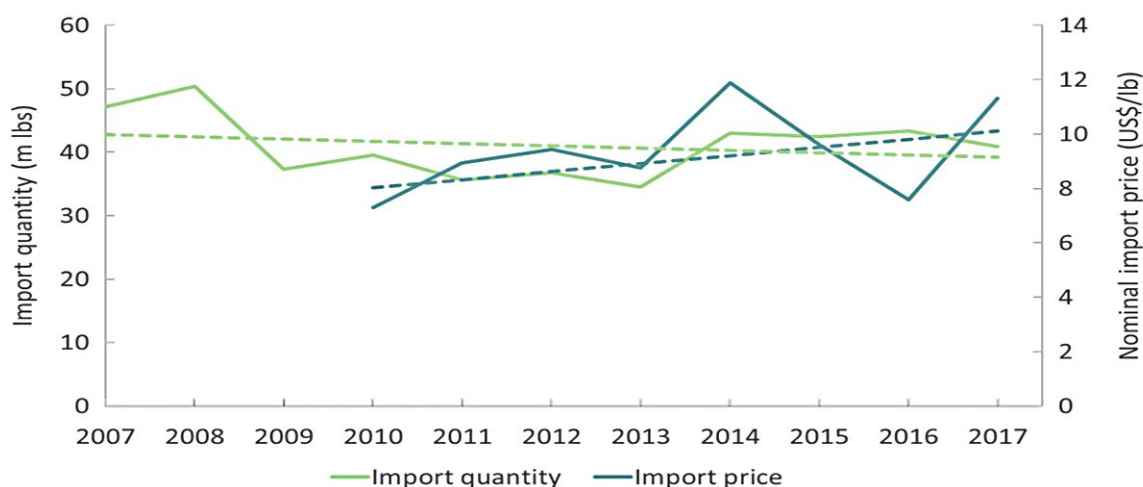

Note: Import price is average declared value for Portunidae crab from Indonesia[4]   ***Source:*** *Urner Barry and Blue Star Foods*

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[4] In the taxonomy of the BSC (Portunus pelagicus), Portunidae is the species' family (Integrated Taxonomic Information System, 2018). A more precise classification for import prices is not possible.

Wholesale prices for all crab meat grades follow the movements in import prices. Prices across crab meat grades move together, indicating a common market (see Figure 6) and that price volatility cannot be explained by changes in demand for different grades. For example, the wholesale price for Jumbo meat, the most expensive grade, increased between 2007 and 2017 from $19.34/lb to $26.76/lb (or 38%), in line with the price increase in other grades, suggesting that there are similar trends in price movements of different grades and therefore they can be modelled as one (average) product. Furthermore, short-term movements in wholesale prices are correlated with movements in import volumes.

Figure 6. *Wholesale prices of all crab meat grades move together and in line with quantities*
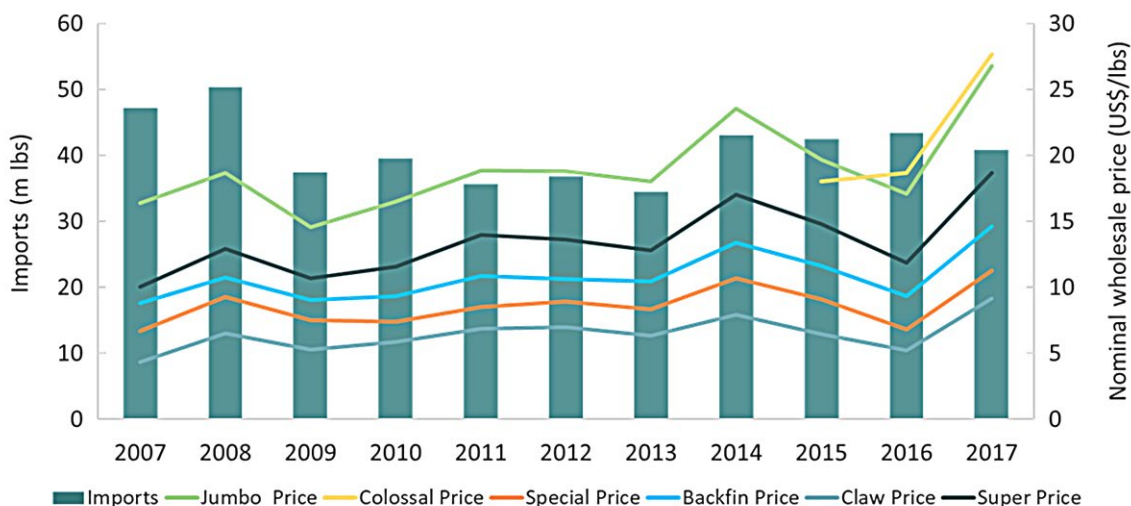
Source: Blue Star Food

Unsustainable fishing practices partly drive this volatility in import volumes and prices. According to interviews with industry members of the Crab Council, weak management of crab fisheries in Southeast Asia is one of the key drivers of volatility in crab production costs. As stocks decline without proper management in place, it is more costly for fishers to catch the same amount of crab, thus leading to an increase in the harvest cost. With low volume catches also comes increases in price per crab. All of these cost increases are passed up through the supply chain. Other drivers of volatility include fluctuations in currency exchange rates and swings in demand for the crab meat. While some partial stock assessments clearly indicate declining stock health of BSC in some regions of SEA, there are no systematic assessments of the BSC stock in SEA countries to scientifically prove this hypothesis[5]. At the same time, the spread in price between meat from large, mature crab and smaller crab has widened by 23% in ten years, with Claw-Jumbo spread jumping from $14.25/lb in 2007 to $17.59/lb in 2017 (see Figure 7), consistent with a squeeze on mature crab supply, a sign of over-fishing.

Figure 7. *The price premium for Jumbo has increased relative to Claw*
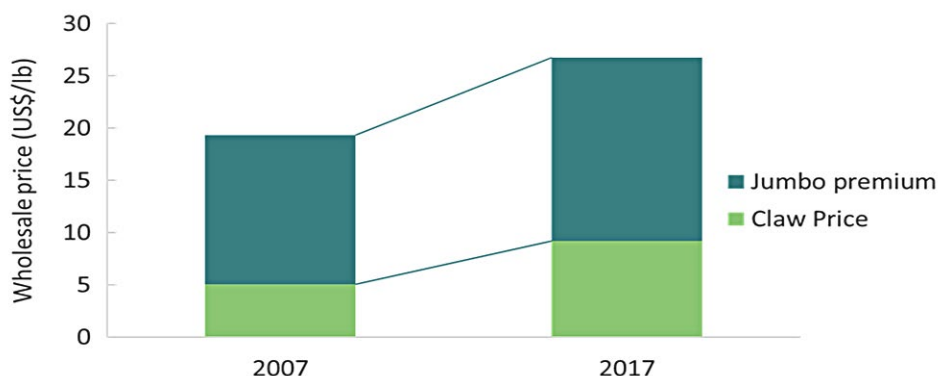
Note: Real prices in 2017 US$ *Source: Vivid Economics*

[5] There are some partial assessments, such as in the Kung Krabaen Bay in Thailand (Kunsook, Gajaseni, & Paphavasit, 2014) or the Kien Giang Waters in Vietnam (Ha, Nhan, Cuong, & Doan, 2014), indicating a decline in stock health. However, no large-scale assessment has been undertaken and biomass has not been tracked over time, preventing causal claims between stock health and volatility in import prices.

2.3 Scenarios for future cost increases

Future import price scenarios undertaken in this analysis are based on historic data. Figure 8 depicts annual deviations from the mean import price over the period between 2010 and 2017. Historically, prices swing up to 27% higher than the mean and down to 22% lower than the mean. US importers suggest that similar cost shocks are likely in the future, since no particular improvements in the management of the SEA fisheries or changes in exchange rate volatility are expected.

***Figure 8.*** *Deviation from the mean inform the cost shock scenarios*
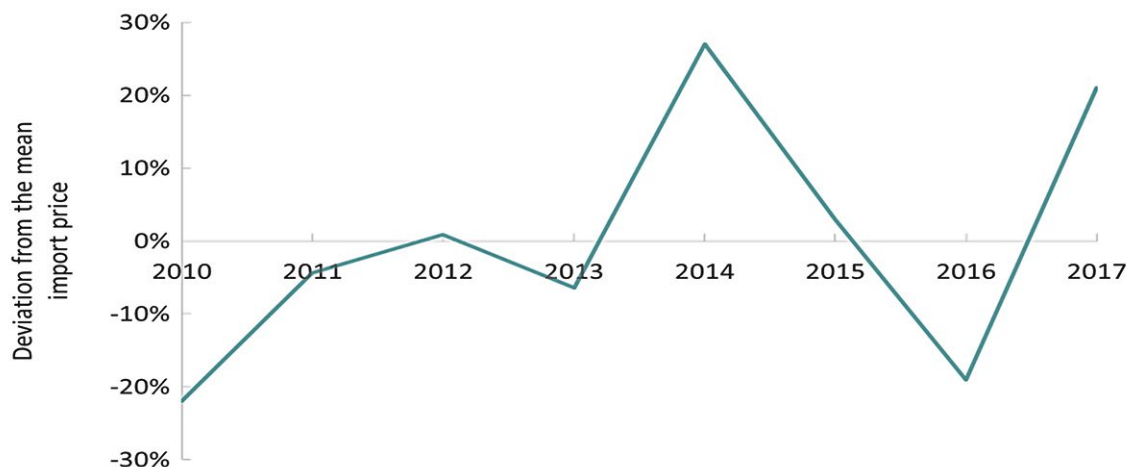
Note: Import price is average declared value for Portunidae crab from Indonesia   ***Source:*** *Urner Barry*

Import prices for Indonesia, Philippines, Vietnam, and Thailand are independently as well as jointly shocked by +15% in the cost scenarios explored in this study. This is approximately the median of the average historic price increases in the past decade. No shocks are applied to Sri Lanka, China, and India, reflecting their lower reported volatility.

Figure 9 summarizes potential causes of import cost increases along the value chain and indicates which parts are modelled.

Figure 9. *Unsustainable fishing practices can affect all parts of the value chain*
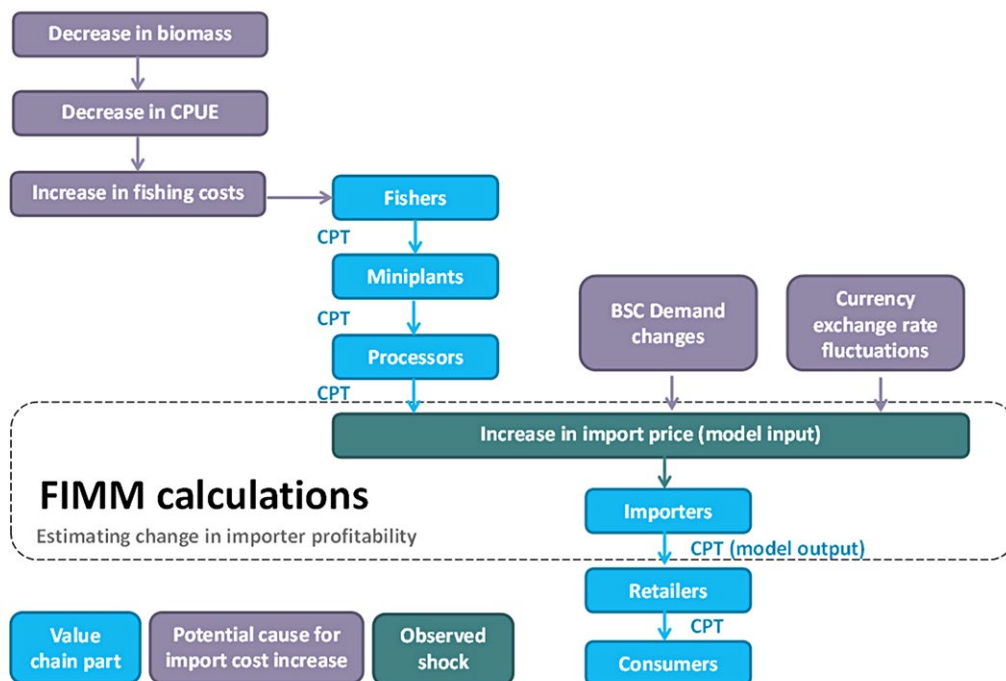
Source: *Vivid Economics*

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3 MODEL RESULTS

Crab availability affects US buyer profitability

3.1 Cost pass-through (CPT)

When Indonesia alone is shocked by a cost increase, about one third of the cost is expected to be passed through to retailers in the US. In this example, the US wholesale price increases by $0.60/lb, a 4% increase, due to a 15% increase in import prices. The cost pass-through (CPT) rate for individual firms ranges between 29% and 38%[6].

The CPT rate is higher when a larger proportion of the market experiences a cost increase. If a large share of the market is shocked, the industry copes by passing these costs through, while if only a minor part of the market is shocked, prices adjust little as most firms are not affected. When all SEA countries are shocked, 72% of the market, CPT is between 49% and 65%. The wholesale price is expected to increase by $1.02/lb, by 7%, due to a 15% increase in import prices across all of SEA. For smaller fisheries, with a low market share, sole shocks for these countries, such as Vietnam and Thailand, have a much lower expected CPT rate, of below 5% (see Figure 10).

Figure 10. *Cost pass-through depends on the market share of the countries experiencing a cost shock*
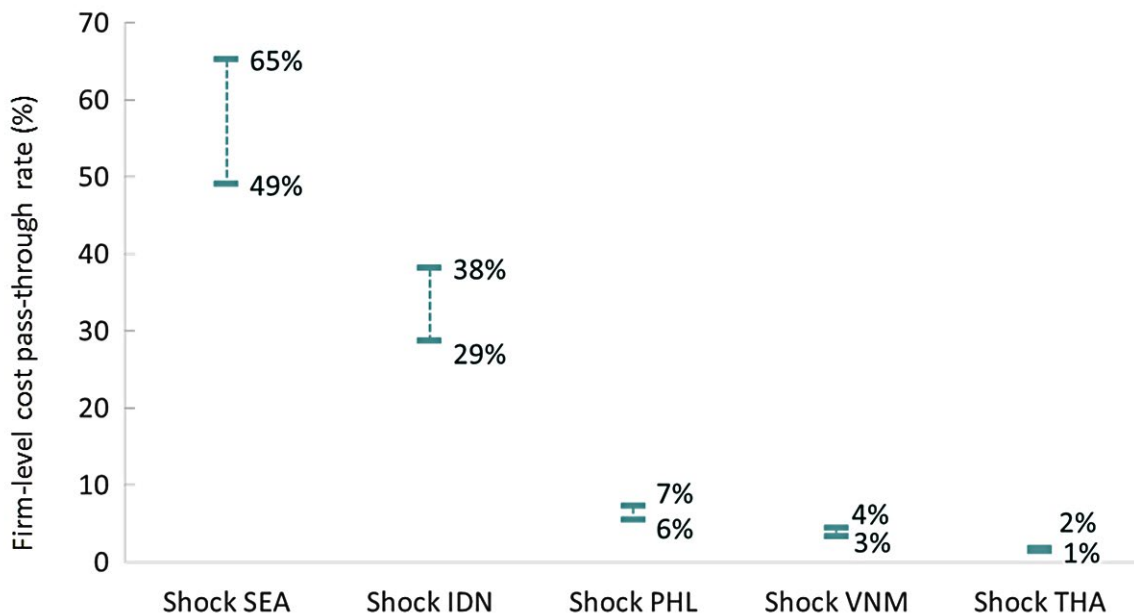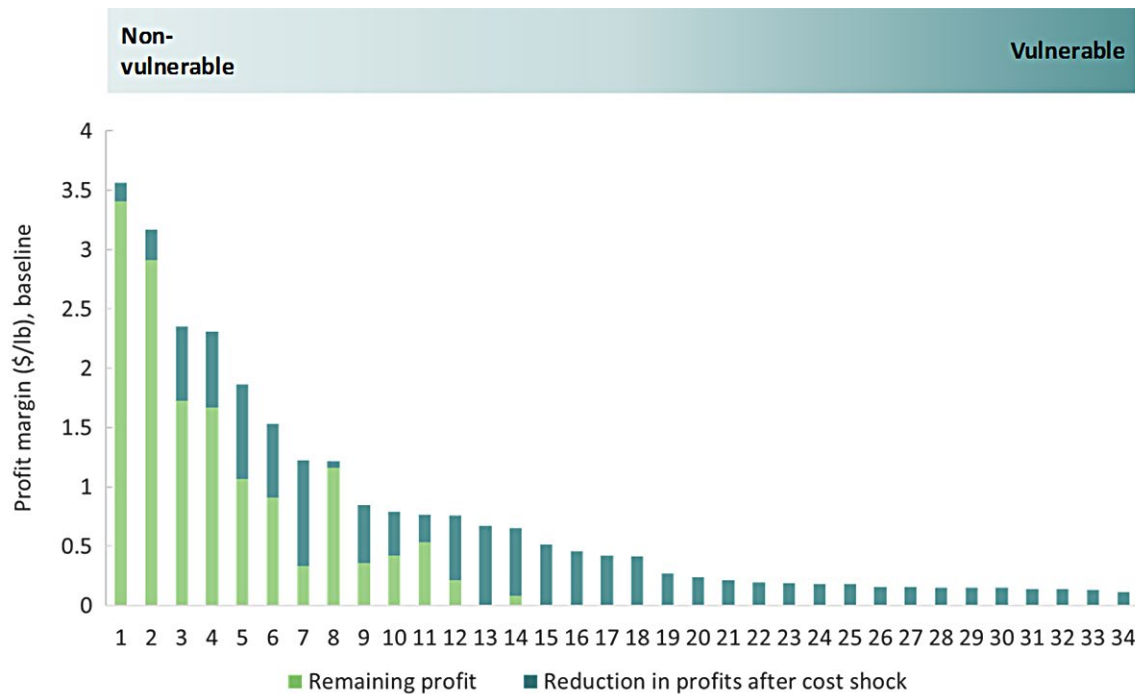

Source: Vivid Economics

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[6] Larger firms have higher cost-pass through rates as they have lower $/lb cost than smaller firms due to economies of scale. Therefore, it is assumed that they face a smaller absolute increase in costs compared to small firms, for the same proportional increase in cost for the market.

3.2 Firm-level margins and market shares

Non-vulnerable firms can absorb cost increases and continue trading. Figure 11 shows the effect on profit margins of individual firms after a 15% cost shock in all SEA countries. The five largest firms have high initial margins that allow them to remain profitable after the cost shock. On average their margins fall by 24%, and their profits decrease by 22%.

Vulnerable firms become financially distressed. In the same cost scenario, small and medium-sized firms lose on average around 56% of their margins and 70% of their profits. This is driven by two factors. First, most of these firms are not diversified, making them exposed to increases in import costs from individual countries. Second, their initial margins are low, depriving them of the capacity to absorb costs.

Figure 11. *Non-vulnerable firms absorb cost shocks whereas vulnerable firms suffer distress*

Note: Results not reported for firms importing more than 50% from India or China   ***Source:*** *Vivid Economics*

Firms that are well-diversified and source from countries with larger market shares lose little of their margin. This is shown in Table 1, which lays out the impacts on profits per lb. of four large firms across different cost shock scenarios.

— Firm A is relatively diversified, with a HHI of 29%, but still sources a large proportion of its imports from Indonesia.

— Firms B and C are similarly diversified, HHIs of 49% and 46% respectively, but Firm C sources mainly from the smaller fishery Philippines while Firm B sources mainly from Indonesia.

— Firm D is least diversified and sources exclusively from Indonesia.

Their initial margins differ, related in the model to variation in firm size, but the impact of shocks is mainly driven by their levels of diversification.

— When Indonesia is shocked, Firm A, being more diversified, loses only 4% of its margin, while Firms B and D, being less diversified, lose 20% and 65% of their margins, respectively.

— When the Philippines is shocked, Firm C loses 42% of its margin, significantly more than Firm B under an Indonesia shock, despite having similar initial margins and similar level of diversification. This is because Firm C imports mainly from the Philippines, which has a smaller share of the market and therefore a lower cost pass-through.

— When all of SEA is shocked, diversification outside SEA matters. Firm A, which imports 21% from outside of SEA, faces a relatively lower reduction in its margin.

Table 1. *Impact on margins depends on the diversification strategy of the firms*

Firm	Main sourcing country		Initial profit ($/lb)	Change in profit ($/lb)		
				Shock IDN 15%	Shock PHP 15%	Shock SEA 15%
A		Indonesia	3.17	-0.12 (-4%)	-0.15 (-5%)	-0.26 (-8%)
B		Indonesia	2.31	-0.47 (-20%)	-0.48 (-21%)	-0.64 (-28%)
C		Philippines	2.35	+0.19 (+8%)	-0.98 (-42%)	-0.63 (-27%)
D		Indonesia	1.87	-1.22 (-65%)	+0.11 (6%)	-0.80 (-43%)

Note: *Detailed sourcing: Firm A 44% IDN, 21% IND, 13% VDM, 16% PHP, 5% THA; Firm B 61% IDN, 34% PHP, 5% CHN; Firm C 24% IDN, 63% PHP, 4% CHN, 1% IND, Firm D 100% IDN*
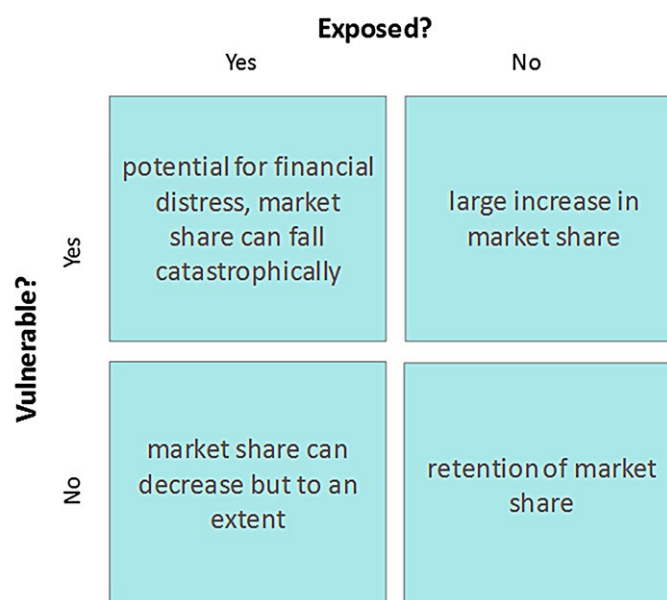
Source: *Vivid Economics*

The impacts on market shares of firms are similar to the impacts on margins.

Non-vulnerable firms lose some market share, depending on their exposure. Figure 12 describes the importance of exposure and vulnerability for market shares. When SEA costs are shocked, large diversified firms are expected to roughly retain their market share. In the same scenario, large undiversified firms are expected to lose 32% to 47% of their market share.

Vulnerable firms can lose most of their market share and become financially distressed. Most of these firms have a low level of diversification, leaving them highly exposed to cost shocks. Vulnerable firms who source little from SEA are not exposed and have the potential to increase their market share.

Figure 12. *The effect of the cost shock depends on a firm's level of exposure and vulnerability*
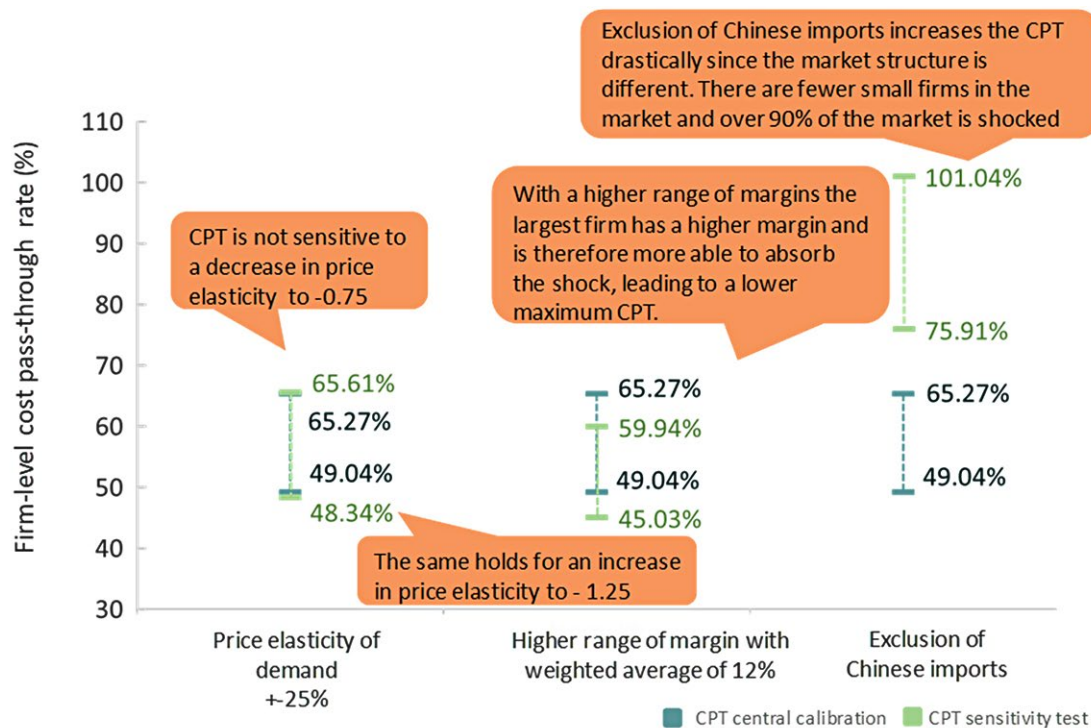

Source: *Vivid Economics*

3.3 Sensitivity analysis

This section explores the sensitivity of the model results to price elasticity of demand, distribution of initial margins and China's inclusion in the market.

The cost pass-through rate is relatively insensitive to changes in price elasticity of demand. When the price elasticity is increased from -1.0 to -1.25, the lower bound of CPT changes slightly from 49.04% to 48.34%, a slight decrease (see Figure 13). Likewise, when the price elasticity is reduced to -0.75, the upper bound of CPT increases slightly from 65.27% to 65.61%. The direction of sensitivity is as expected; that is, firms can pass through more costs when demand is more inelastic (when the elasticity takes a smaller negative value), as quantity demanded falls less in response to a price increase.

Figure 13. *CPT rate is especially sensitive to China's inclusion in the market*

Note: CPT central calibration is for 15% shock to SEA   ***Source:*** *Vivid Economics*

The CPT rate is somewhat sensitive to changes in the distribution of initial margins. When the model is calibrated to a wider range of initial firm margins, with an average of 12%, more firms are vulnerable to cost shocks and there is a wider range of differences in competitiveness between firms. The largest firm has a substantially higher margin and is therefore able to absorb a greater amount of the cost shock, which lowers the maximum CPT rate to 60%. At the lower end, fewer firms are able to sustain a positive margin, which cushions the shock for the remaining firms and leads to a lower minimum CPT rate of 45%.

The exclusion of Chinese imports has a substantial effect on the CPT rate. Imports from China specifically are known to include red swimming crab, which is a partial but inferior substitute for blue swimming crab. This sensitivity tests how the market is affected if there are no known red swimming crab imports, or if red swimming crab is not a close substitute for blue swimming crab, by excluding imports from China altogether. When Chinese imports are excluded, the model setup changes in two ways. First, many small firms sourcing from China are excluded from the market. Second, with China excluded, more than 90% of the market is shocked when a cost increase to SEA is applied. Therefore, the lower and upper bound of CPT increases by around one-half to 76%-101%[7].

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[7] A CPT of more than 100% means that the wholesale price increases more than the initial cost increase. This can occur, for example, when many firms exit the market and the remaining firms have more market power.

Margins for large firms change approximately linearly with the changes in magnitude of cost shocks. Figure 14 shows the unit profit across levels of cost shocks for the four firms from Table 1 and an additional Firm E. The two largest firms, A and E, are able to remain in the market even at a cost increase of 55% for SEA.

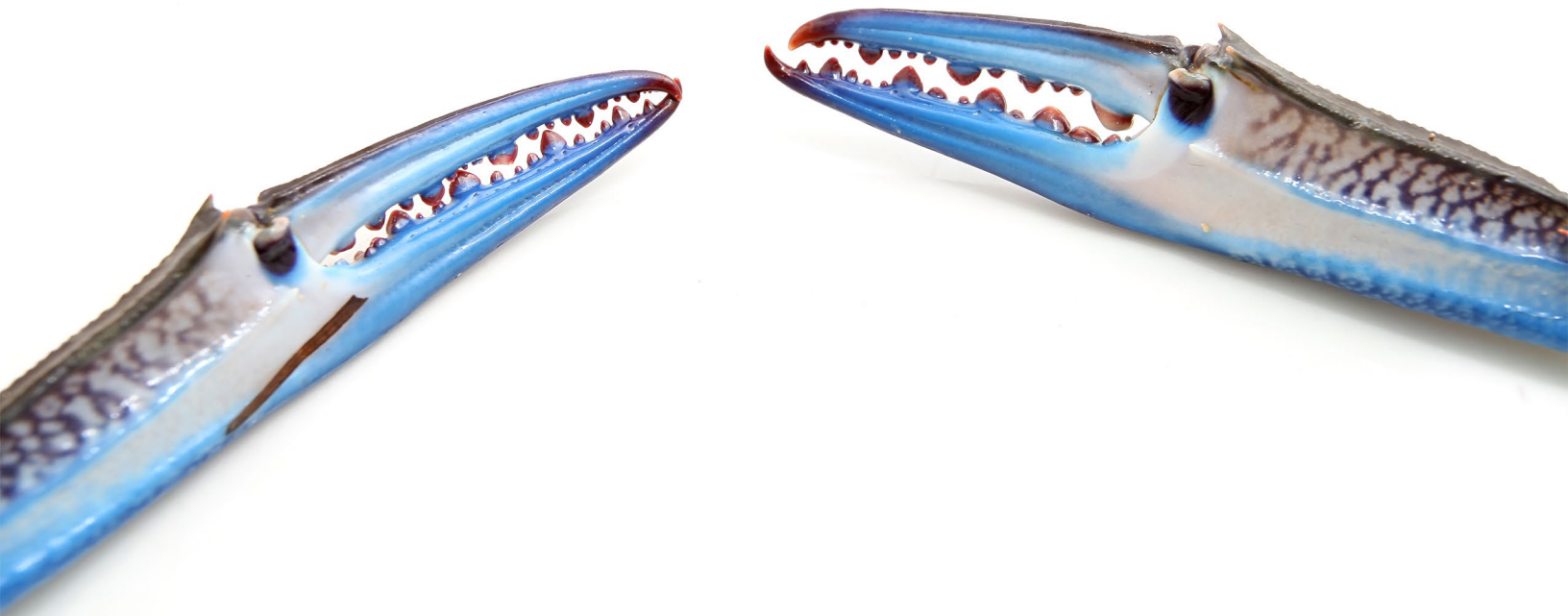***Figure 14.*** *Two of the five largest firms do not have positive profits at a cost shock of 40%*
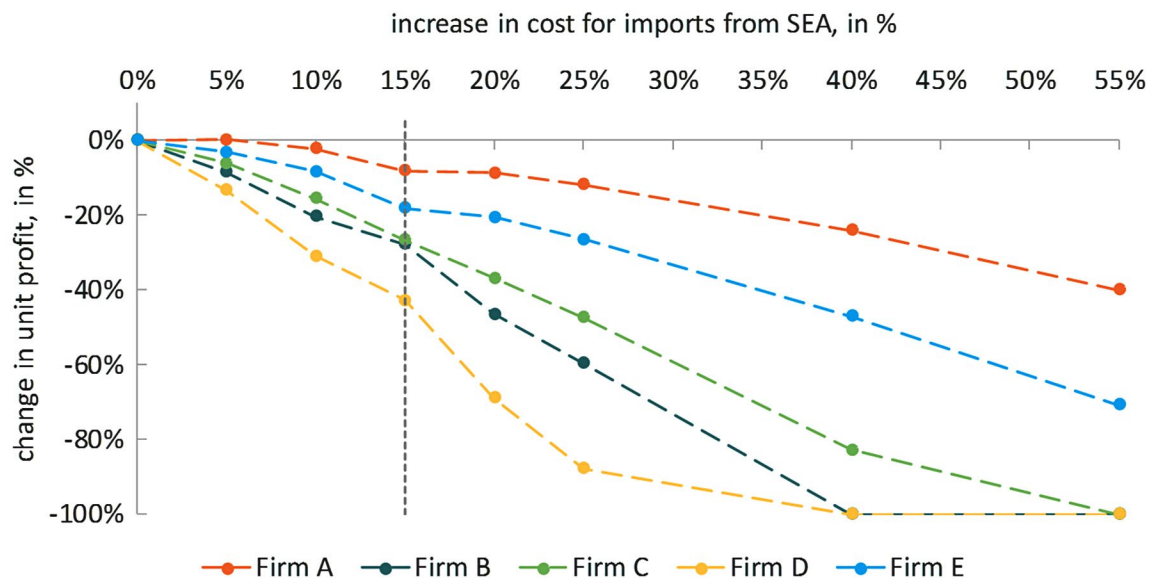
Note: *Initial unit profit in $/lb: Firm A 3.17, Firm B 2.31, Firm C 2.35, Firm D 1.87, Firm E 3.56. The slight non-linear changes across cost shocks are driven by firms exiting after higher cost shocks.*

Source: *Vivid Economics*

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4 CONCLUSIONS

Better management of fisheries would boost US buyer profitability

Model results

Cost pass-through rate varies by country of supply. For countries with smaller market shares, such as Thailand or Vietnam, cost pass-through for firms importing from these countries is less than 5%, while for larger countries like Indonesia it is 29-38%. The cost pass-through is higher when a larger proportion of the market experiences a cost increase.

Impacts on firm margins and market shares depend on vulnerability and exposure. Larger firms are less vulnerable as they have higher margins, while small and medium-sized firms are more vulnerable. Firms that are well-diversified in import sourcing and import from countries with higher market shares are less exposed, as they can pass through a large proportion of the cost increases to the retailers.

Recommendations

Firm-, industry- and government-level action is needed to mitigate the supply chain impacts of volatility in import prices.

Individually, firms can implement short-term strategies that mitigate impacts by reducing their exposure and vulnerability to cost shocks. Diversification in import sourcing and switching purchasing towards countries with larger cost pass-through rates could reduce the exposure of firms to cost shocks. However, diversification is a short-term strategy and a partial substitute for better resource management. Firms can also reduce vulnerability by merging, if in so doing they can increase their margins. Both strategies have already been adopted by some firms in the past, while other firms might lack the resources to adapt. However, while both approaches could cushion the effects of cost increases, firms sourcing from exploited fisheries will still experience negative financial impacts. In the long-term, these strategies will eventually fail, if the stock health and resource resilience issues are not addressed. Therefore, action towards improving the health of the BSC stock in SEA remains necessary to address effects on profitability; both in the short term for small, vulnerable companies and in the long-term for the whole industry.

Continued action by the NFI CC could reduce volatility in source countries. For example, enforced crab meat grade standardization could reduce the catching of undersized crab (Wilderness Markets, 2018), improving the health of the fisheries. NFI CC members are already committed to limits on minimum size of crab and egg-bearing females but interviews with stakeholders suggest that compliance and enforcement are low. If enforced, these standards could improve the state of the

fisheries and profitability of US importers. However, this could be undermined if non-members increase their market share because of these standards. The US is a large market for SEA BSC[8]. However, since the Crab Council members account for around 70% of the disclosed US BSC imports, continued industry-led action could be effective[9].

Better management of the fisheries in supply countries is needed in the long term. Higher biomass offers higher CPUE, reducing costs and volatility in costs. Smaller countries can expect the highest returns from improving fishery management, as cost pass-through rates are lower for products from these countries, so firms importing from these countries are at greatest risk of losing market share when costs increase. Similarly, countries with high concentrations of small exporters would have higher returns from fishery management improvement.

Applicability to other fisheries

The findings are transferable to other fisheries. Unsustainable management of a stock increases fishing costs and these cost increases are partly passed along the supply chain. How substantial and regular these shocks are, depends on the stock characteristics, management and fishing pressure on the stock. The impacts on buyers of other seafood depend on the market structure. The share of costs a given industry will be able to pass through to costumers will depend on firms' initial margins and elasticities, among other factors. Firms operating in other fisheries can use similar analysis to make the business case for good fisheries management.

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[8] Estimations of the share of the US market vary, but most sources suggest they account for more than 50%. One report estimates the share for BSC exports from Indonesia at almost 90% (California Environmental Associates, 2014).

[9] See Wilderness Markets report for more detailed recommendations on NFI CC actions: *Precompetitive Private Sector Engagement Platforms and Business Profitability: A study of the formation of the NFI Crab Council and the blue swimming crab industry.*

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APPENDIX: MODEL SET UP AND ASSUMPTIONS

Model description and structure

Vivid Economics has developed an in-house model for analyzing interactions between firms and consumers within capital intensive industries, referred to as the Full Industrial Market Model (FIMM). The model depicts an economic market and captures the impact of changes in market structure, including the entrance or exit of individual firms, changes in demand, and changes in production costs. The model is based around the Cournot model of oligopoly, familiar to academic economists, and is conceptually similar to the qualitative Porter's Five Forces model, widely used in corporate strategy analysis. It is a partial equilibrium model, solved algebraically.

The model has been successfully employed in a wide range of applications. The model is grounded in established economic theory and has been vetted extensively by the UK Department of Energy and Climate Change, the European Commission, and private companies.

Figure 15 provides a schematic of the modelling process. After the model has been calibrated to produce an estimate of market competitiveness, as shown in the top part, shocks in terms of import costs proportional to the share the firm sources from the shocked country are applied. These shocks increase per-unit production cost, resulting in changed margins, market share and a new market price.

Figure 15. *Simplified depiction of Industrial Market Model structure*
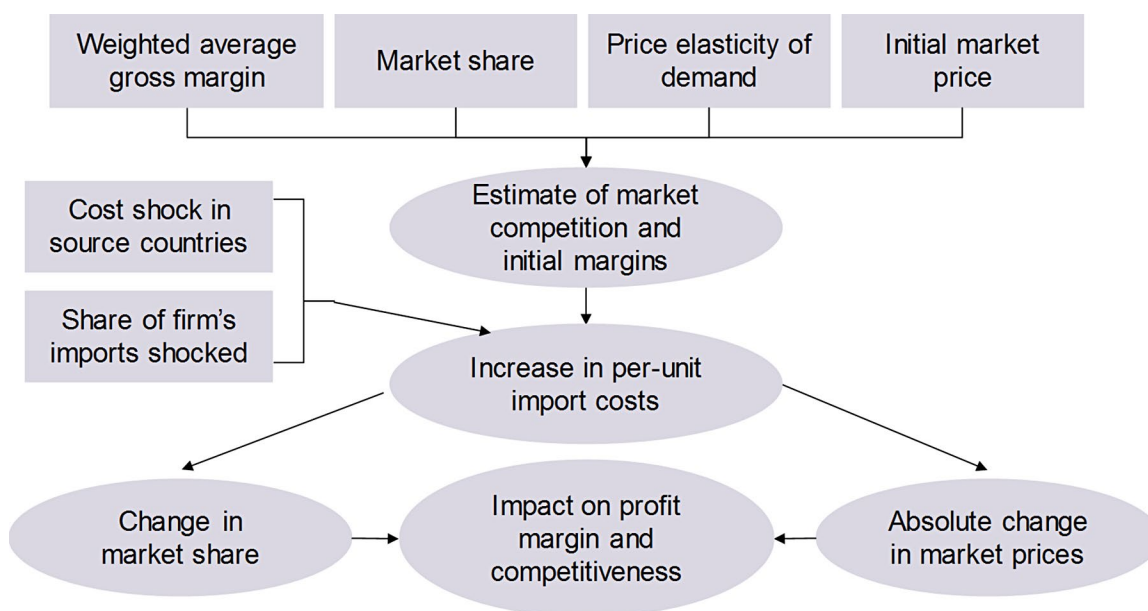
*Note: Rectangular boxes represent inputs, ovals represent intermediate and final outputs.*   ***Source:*** *Vivid Economics*

There are three steps to using the FIMM:

— data is compiled on market prices, quantities sold and the market shares of individual importers within the market, as well as the country shares of each firm. These data allow the estimation of marginal costs of production of each firm, which can be calibrated against quantitative or qualitative information obtained elsewhere;

— using the data on country shares, an estimate is made of the impact of cost shocks to specific countries on firms' marginal costs;

— from here, a new equilibrium is calculated, and consequent changes in market share, price, quantity and cost pass-through can be identified.

This process is represented in Figure 16.

Figure 16. FIMM involves shifts between static equilibria
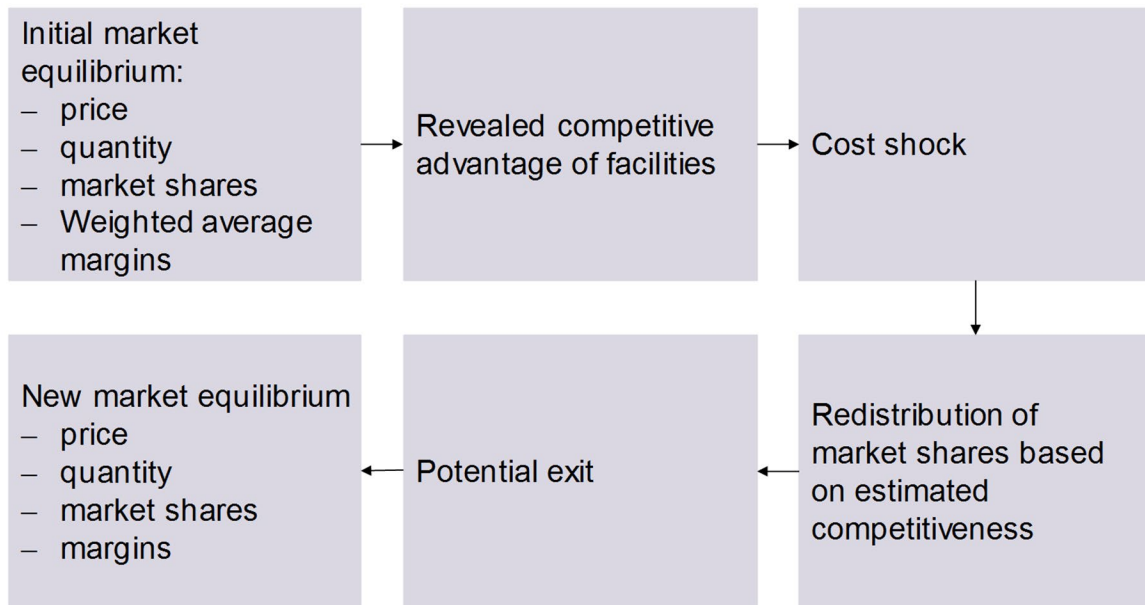
Source: Vivid Economics

To summarize the key features of the model:

— it explicitly represents firm-to-firm and consumer-to-firm interactions encompassing a range of profit-maximizing and sales-maximizing behaviors;

— it allows for changes in output by existing firms or assets as well as entry or exit;

— it allows consumer behavior, whether price sensitive or insensitive, to be included;

— it considers each firm or major asset individually, allowing differences in unit cost or behavior on a firm by firm basis;

— it is based upon the well understood Cournot quantity competition economic framework;

— it allows for cost differentials across national or administrative boundaries;

— it can be calibrated, audited, and subjected to sensitivity and scenario analysis;

— it can integrate qualitative information gathered during expert interviews; and

— it explicitly accounts for strategic interactions between firms when determining cost pass-through, rather than relying on aggregate relationships.

The model assumes that the market is in equilibrium before the cost shock is introduced and is in equilibrium afterwards. This implies that all firms are optimally responding to the production strategies of their competitors, and that, in the absence of a cost shock, firms would not adjust their production plans. This may not be the case; firms may be in the midst of expanding capacity, or on the verge of shutting down. This version of the model deals with states of equilibrium, so it represents outcomes once firms have adjusted to new market conditions, a process of adjustment which may take around three years in practice.

Assumptions

Table 2. *Assumptions underlying FIMM model*

Variable	Value	Unit	Source / Notes
Price elasticity of demand	-1	unitless	Nguyen, Hanson, & Jolly (2013) estimate the price elasticity of crabs at the US retail level to be -.77. Since the BSC is a specific species of crab, elasticity is expected to be higher (in absolute terms). An explicit estimation of the price elasticity for BSC is not available. The sensitivity tests in 3.3 show that the results of this report are insensitive to different levels of elasticity.
Gross margins		%	Calibrated to a maximum margin of 25% based on interviews with US importers. There is some level of disagreement between stakeholders on market margins. Sensitivity in Section 3.3 explores a higher range of margins and steepens the link between market shares and profitability.
Initial market price	13.98	$/lb	
Initial market size	40,845,391	lbs	Data from Blue Star Food based on Urner Barry. The firm has extensively vetted single entries in the Urner Barry database to get an accurate sense of the market size.
Exogenous market growth	0	%	There is no indication that the market for BSC would grow in the future.
Calculation of cost increases			Cost shock in source countries affect firms as a percentage of their initial unit costs. Furthermore, the cost shock is proportional to the share a country sources from the shocked country. For instance, if Indonesia is shocked by 15% and a firm sources 60% from this country, its unit costs increase by 60%*15%=9%.
Import sourcing			Firms are assumed to not be able to change their country source composition in a given year.
Firm representation			Imports act as multinational group entities rather than as independent subsidiaries operating at a country level.
Minimum firm market share	0.25	%	Since some imports are disguised or not clearly labelled, small amount of imports would appear as separate firms in the model. This would lead to a substantially larger number of firms in the market than reported in interviews with minimal margins. The market share threshold has been chosen in a way to resemble a plausible number of firms. It translates to a quantity threshold of 101,714 lbs, eliminating 47 'firms'. The quantity of these firms (2.4 m lbs) has been distributed to the remaining firms according to their market share.

Source: *Vivid Economics*

Data sources

The Full Industrial Market Model uses the following data:

— quantity of BSC imported by each importer

— country origin of these imports

— initial wholesale price

The data has been taken from Urner Barry for the year 2017. The company provides data and market information on seafood imported to and traded in the US. Import quantities and country shares are taken from Urner Barry's custom database, which is based on voluntary disclosure by importers. The data used for the FIMM has been filtered in cooperation with Urner Barry, the NFI CC and US importers.

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Vivid Economics is a leading strategic economics consultancy with global reach. We strive to create lasting value for our clients, both in government and the private sector, and for society at large.

We are a premier consultant in the policy-commerce interface and resource- and environment-intensive sectors, where we advise on the most critical and complex policy and commercial questions facing clients around the world. The success we bring to our clients reflects a strong partnership culture, solid foundation of skills and analytical assets, and close cooperation with a large network of contacts across key organizations.