NEW AQUACULTURE SPECIES – ENTERING THE WHITEFISH MARKET

by

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Abstract

Aquaculture production has increased rapidly during the last three decades. This is due to increased production of established species as well as a continuous introduction of new species. Productivity growth is the main engine for the increased production in aquaculture, and as the accumulated knowledge is applied to new species and in new regions, production is expected to continue to increase. Along with the production growth an increasing quantity of aquaculture products is being internationally traded. This is rapidly changing several segments of the global seafood market. While high value species such as salmon and shrimp were the first to be traded internationally, low cost species like tilapia and pangasius are currently transforming large parts of the whitefish market.

Keywords: Aquaculture, production growth, whitefish, pangasius, tilapia

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INTRODUCTION

The structure of the global supply of seafood has changed significantly during the last decades. The two most prevailing trends are stagnation in the harvest of wild fish and increased production from aquaculture. These trends can be seen in figure 1, where the production from wild fisheries and aquaculture is shown together with total seafood production. In 1970, aquaculture production was still limited, with a quantity produced of about 3.5 million tonnes, representing 5.1% of the total seafood supply. In 2006, aquaculture made up 41.8% of total seafood supply, with a production of 66.7 million tonnes (FAO, 2008). Wild fisheries production since the late 1980s has fluctuated between 90 and 100 million tonnes in annual landings with no particular trend. The increased production in aquaculture is accordingly the only reason why global seafood supply has continued to increase since 1990.

Aquaculture is a production technology with origins thousands of years ago in China. However, a significant change has taken place since the 1970s, as better control of the production process enabled a number of new technologies and production practices to be developed and implemented. This has improved the competitiveness of aquaculture products as a source of basic food and a cash crop. The competitiveness of aquaculture has been further increased through product development and marketing, made possible with a more predictable supply. The combined effect of productivity and market growth has made aquaculture the world's fastest growing animal based food sector during the last decades (FAO, 2006).

The increased production from aquaculture has had a significant impact in a number of markets. A substantial increase in production usually results in a significant drop in the price of that species. Shrimp and salmon are good examples of species where production increases have been accompanied by significant reductions in price. A similar development can also be found for other species like sea bass, sea bream and catfish, although the strength of the price decline varies (Asche, Bjørndal & Young 2001). Somewhat simplified, one can say that following an increase in production, there are two main market structures that an aquaculture industry can face. If the market size is limited, and there are few other species or products from which one can win market share, prices will decline rapidly as increased supply are forcing a movement down along the demand schedule.[1] Alternatively, if there is a large market where the producer in question only produces a minuscule share, there may be a weak or no price effect as one is winning market share.[2] For instance, the main reason for shrimp prices declining at a lower rate than salmon is that the global production of wild shrimp is substantially larger than wild salmon production.

For almost three decades, shrimp and salmon have been the leading aquaculture species in the international market for farmed seafood, with productivity growth and reduced production costs as the engines of growth (Anderson, 2003; Anderson, Asche & Tveterås, 2009). However, an increasing number of species, including many low-priced species, are now entering the international seafood market in significant volumes. Producers of these species are partly learning from the experiences of shrimp and salmon when it comes to production, logistics and marketing, and partly inventing new approaches to exploit their own competitive advantage. This is a natural and necessary development if aquaculture is to fulfill its potential as a major food source (Asche, 2008). In this paper, we discuss this development, as it provides important lessons that shed light on how aquaculture production will continue to grow. We also focus particularly on the whitefish market, where the most dramatic changes have taken place during the last decade.

The whitefish market is attractive for any fish supplier, as it is one of the largest segments in the seafood market (Johansen, 2008). Depending on which particular species are included, the quantity of whitefish landed ranges from 6 million tonnes (if only the most important wild species like Alaskan pollock, Atlantic and Pacific cod, haddock, hake and saithe are included) to almost 15 million tonnes (when flounder and smaller whitefish species along with farmed species like sea bass, catfish, pangasius and tilapia are incorporated). In this paper, we give particular attention to two of the most successful species in recent years as measured by the increase in production: namely, pangasius and tilapia.[3] These species are introducing a new market dimension, as they make large quantities of farmed whitefish fillets available at very competitive prices.

Pangasius and tilapia are subtropical species with high growth rates and low production costs. Pangasius is produced virtually only in Vietnam's Mekong delta, and production is accordingly highly concentrated geographically. The pangasius production, primarily exported as frozen fillets, reached one million tonnes in 2007. Tilapia is produced on nearly all continents and in a much wider variety of qualities, with aquaculture production of about 2.5 million tonnes in 2007. The most important traded tilapia product is frozen fillets, but significant quantities of whole frozen fish and smaller quantities of other product forms are also exported. When measured in whole fish equivalents, the quantity of tilapia traded is now approaching one million tonnes, with China as the leading producer and exporter.

The white flesh of the pangasius and tilapia fillets makes a natural comparison to whitefish. However, it is far from obvious in which market segments and with what species these new aquaculture species compete. There are at least two reasons for this. First, the whitefish market consists of a number of species (Gordon & Hannesson, 1996; Asche & Hannesson, 1997; Asche, Gordon & Hannesson, 2004; Nielsen et al., 2007; Johansen, 2008; Andersen et al., 2009) and is constantly developing. New species, like Alaska pollock, hoki and Nile perch, have entered the market during the last decades, and species like flounder and redfish relate to the market but not at the core. Several commentators have also recently argued that cod, the previous market leader in this segment, is no longer a part of the market (Johansen, 2008). As such, it is not clear where new species like pangasius and tilapia enter the market, if at all.

The fact that prices decline for most aquaculture species that are successful when measured by the increase in quantity produced indicates that the size of the market is a constraint for further development of these species (Asche, Bjørndal & Young 2001). It also indicates that productivity growth, leading to lower production costs, is necessary for increased aquaculture production. An interesting feature with low-price species like pangasius and tilapia is the extent to which they face similar market constraints as higher-valued species, or whether they can prevent declining prices by winning market shares in established markets.

AQUACULTURE PRODUCTION

A number of species are farmed across all parts of the world, in both fresh and salt water. Moreover, a number of different production techniques are being used, as technologies are adapted to the different species, environments, and economic conditions. Cultivation of a new species typically starts up by catching wild juveniles and feeding them in a controlled environment (Moksness, Kjørsvik & Olsen, 2004). As more experience and knowledge is gained, the degree of control with the production process increases, and the farmers can increase their influence on growth and reproduction. In turn, the degree of control is often categorized by the intensity of the aquaculture operation.

Traditional aquaculture ranges between *extensive* and *semi-intensive*. The small ponds used in Chinese aquaculture were traditionally operated on an *extensive* basis, as the farmer did little to control growth and biomass. While this system is still common, many farms have become *semi-intensive* as farmers actively feed their fish to enhance production and undertake other productivity-enhancing measures, including greater densities. In recent years, one can also observe a growing number of large intensive facilities in China, the largest producing country.

In *intensive* aquaculture, the production cycle is closed such that there is no dependence on wild fish for reproduction. Fish are then reared in confined areas, and the farmer controls most aspects of the production process, including farm size and the stocking and feeding of fish.

Control of the production process is the most important factor in the growth of aquaculture (Anderson, 2002; Asche, 2008). This control enables innovation and the systematic gathering of knowledge that creates further growth. As such, it is the transition from *extensive* to *semi-intensive* farming, and particularly the feeding of the fish, that is the most important factor in the growth of aquaculture production. As species with highly *intensive* production systems lead the way in technological development, the production process for an increasing number of species is likely to become more *intensive* with the adoption of new technologies. Control of the production process also allows better logistics and marketing (Asche, Roll & Tveteras, 2007; Engle & Dorman, 2007).

Aquaculture is a truly global production technology, with close to 180 countries reporting at least some level of aquaculture production. However, as shown in Table 1, there are substantial regional differences. Asia makes up about 92% of production measured by volume and 79.6% percent by value. All other regions have a higher value share than volume share, as they produce higher-value products. This is particularly true for South America. China is by far the largest production country, with a value share of about 50 percent and a volume share of 70 percent. Measured by value, Chile, India, Vietnam, Japan, Norway, Indonesia, Thailand, Myanmar and South Korea are the other top 10 producing countries. Egypt is the largest producer in Africa and is ranked 13th on the list. Hence, aquaculture is clearly strongest in Southeast Asia and is primarily conducted in developing countries. It is also worthwhile to note the lower importance of China in terms of value rather than quantity. This implies that there is much low-value aquaculture production in China, including large quantities of carp. Generally, these products cannot be traded on the international market. Nonetheless, China is still the leading exporter of several of the most important traded aquaculture species, including tilapia.

Table 2 provides aquaculture production by species group according to International Standard Statistical Classification of Aquatic Animals and Plants (ISSCAP) groupings (excluding aquatic plants). As shown, herbivorous species, like carp, barbel and other cyprinids, account for a major part of global aquaculture production in terms of volume, making up 40% of the total. This is followed by the miscellaneous group freshwater fishes, oyster, clams and other molluscs. The two species groups shrimp and prawns, and salmon and trout, respectively, makes up only 5% and 4% of total production volume.

A quite different picture emerges when we consider the ranking of species in value terms (Table 3). The group including carp is still the largest, but with 24% of total value, it accounts for a considerably smaller share in terms of value compared with volume. Although eight of the groups on the ‘volume’ list are still on the ‘value’ list, shrimp and prawns have moved from fifth to second, and salmon and trout from sixth to third. Jointly, these groups account for 29% of total value. Hence, the most intensively produced species are also among the most valuable. These species are also among those with the highest export shares, with major trade flows from Southeast Asia, Chile and Norway to the European Union (EU), Japan, and the United States (US). These values also indicate that a significant component of aquaculture production does not compete in the international market, but has its primary role as a basic local food. Several species, like tilapia, play both roles, as they are a cash crop produced for export in some countries/regions and local consumption in other places (Norman-López & Bjørndal, 2009).

INTERNATIONAL TRADE

The international trade in seafood has increased much faster than total seafood production.[4] From 1976 to 2006, the export volume of seafood increased almost fourfold from 7.9 million tonnes to 31.3 million tonnes. Adjusted for inflation, export value during this period increased threefold from 28.3 billion USD to 86.4 billion USD (Figure 2).[5,6] When export quantity increases fourfold and export value only threefold, the unit value of seafood decreases. This has increased seafood's competitiveness as a food source and is an important factor explaining increased trade. In particular, the competitiveness of aquaculture products have increased trade in seafood, and the share of aquaculture in the global seafood trade is steadily increasing.

We can see this most clearly with successful aquaculture species like salmon and shrimp. The profitable expansion in the production of these species is partly due to lower production costs because of improved production technologies and lower costs of distribution and logistics. The lower costs have been important in several ways for making the species more competitive, with real prices now less than one-third of what they were 25 years ago (Asche, 2008). Another reason for the decreasing unit value of seafood is the increased trade in lower-valued species, including tilapia and pangasius.

The trade patterns differ widely between exports and imports. As shown in Figure 2, the export sources in 2006 split almost equally between developing and developed countries. The share of developing countries has increased from 37% in 1976 to 49% in 2006. Improved (and cheaper) transportation and infrastructure has given many developing-country producers access to new markets and led to increased seafood exports. This has been a catalyst for the development of industrialized aquaculture and is the main reason why an increasing number of new species are available at fish counters and restaurants in the EU, Japan, and the US and now increasingly in China and Southeast Asia.

Imports to developed countries comprised 80% of all imports in 2006. Even though the share has declined from 86% in 1976, this means that most of the increased trade in seafood is to developed countries, with a considerable share exported from developing countries. Japan and the US are the two largest importers. However, if we aggregate the EU countries, it is clearly the largest market. Only two of the 10 largest importers, China and South Korea, are developing countries. It is certainly not arbitrary that developed countries receive most imports and that the EU, Japan, and the US are the largest seafood importers. These are the wealthiest regions in the world, with the greatest ability to pay. In a similar manner, economic growth has led to impressive growth for seafood imports in growing economies like China and Southeast Asia (Delgado et al., 2003).

In general, increased trade is beneficial for exporters receiving a higher price for their product. In developing countries, this leads to economic development. It is also beneficial for consumers (and often processors) in the importing country, as the imports provide a higher quantity at competitive prices. For local consumers in exporting regions, increased exports often lead to higher prices. In some cases, this can be a challenge where seafood is a staple for the country's poorest citizens. Increased imports can also have a negative impact on domestic fishermen and aquaculture producers in the import market because imports tend to put downward pressure on the demand for their products. This has led to an increased number of antidumping complaints relating to seafood in the EU and the US.[7]

THE WHITEFISH MARKET

Whitefish is one of the largest segments in the global seafood market. Depending on which species are included, the quantity varies from 6 million tonnes (if only the most important wild species like Alaskan pollock, Atlantic and Pacific cod, haddock, hake and saithe are included) to almost 15 million tonnes (if flounder and smaller whitefish and farmed species like sea bass, catfish, pangasius and tilapia are included). Accordingly, it is an attractive market for most fish producers if they are competitive. Thirty years ago, cod was the most preferred species in this market. However, there were also several cheaper alternatives at the time like saithe and redfish (Gordon & Hannesson, 1996; Asche & Hannesson, 1998; Asche, Gordon & Hannesson, 2004). The price development of these species was determined by cod, as few consumers would buy them if their prices become too close to the price of cod, while demand for the alternative species increased when their prices decreased relative to cod.

In the 1980s, Alaskan pollock and Pacific cod entered the whitefish market, making the price of Alaskan pollock relate to the price of other types of whitefish. A number of other new species also entered this market starting in the early 1990s. These include farmed catfish, hoki and Nile perch. In the US, farmed catfish became the first aquaculture species to enter the market in significant quantities, exploiting the market advantages of an aquaculture species relative to wild-caught species. These included, among others, stable delivery, more efficient logistics, and consistent quality (Kinnucan, 1995). Increasingly, new aquacultured finfish species are entering the whitefish market, with tilapia and pangasius the quantity leaders. Recently, Andersen et al. (2009) have suggested that pangasius compete with wild whitefish species in Russia.

The quantity impact of aquaculture species in the whitefish market is already significant, as quantity exhibits an increasing trend because of aquaculture supply rather than a decreasing trend because of the reduced landing of wild fish in most markets. For instance, Figure 3 shows how US imports of traditional whitefish like cod and pollock has decreased since 1993, but the total quantity is higher because of the increased import of tilapia.

It must here be noted that the rapid development of aquaculture species also creates a methodological challenge when one is trying to measure the market impact of species. The aquaculture industry targets an increasing number of new market segments, and increasingly higher-volume rather than higher-price segments. This development implies that most tests for market integration or substitution will find little evidence of competition between wild and farmed species. Asche, Bjørndal & Young (2001) argue that it is only for very close substitutes when the aquaculture sector is sufficiently large that the price determination process will be the same. This suggests that the econometric delineation of the market for newly farmed species often be very difficult because of its extremely dynamic nature. However, there is increasing recent evidence of market interaction between farmed species and the traditional seafood market beyond competition of wild and farmed product of the same species (Nielsen et al., 2007; Andersen et al., 2009). Hence, the whitefish market not only became global during the last few decades, but also grew as new species entered and influenced the price determination process.[8]

NEW SPECIES

Two of the most successful species in recent years as measured by the increase in production are pangasius and tilapia. These are subtropical species with a high growth rate. For both species, most production takes place in developing countries. Pangasius and tilapia are introducing a new dimension in the market, as they make large quantities of farmed whitefish fillets available at very competitive prices.

Tilapia

Tilapia is originally an African species now produced on all continents. China is the largest producer, with about 50% of production, followed by Egypt, Indonesia, the Philippines, Thailand, Taiwan, and Brazil. Production techniques differ substantially, from *semi-intensive* to highly *intensive*. While not carnivorous in nature, tilapia grows faster with fishmeal-based feed. Tilapia grows quickly and can reach a marketable size of 500–800 grams in as little as three months. Tilapia's main strength is its versatility, even though the fillets are rather small, with a fillet yield of only about 40%. It grows well under a wide variety of conditions, and while it is a freshwater species in nature, breeding has brought forward varieties that can grow in brackish water.[9] Indeed, many observers believe that it is only a matter of time before a variety suitable for marine aquaculture will be available. Overall, this makes tilapia a highly adaptable species. Moreover, with a production cost that can be lower than one USD per kilo, it is already highly competitive in cost, and productivity is still improving.

Tilapia is rapidly becoming one of the world's most important aquaculture species. In 2007, produced quantity produced passed 2.5 million tonnes. Tilapia is not a new species in aquaculture, as production was over 1,500 tonnes in 1950 and more than 12,000 tonnes in 1970. However, it was not until the 1980s that tilapia became a major farmed species. In Figure 4, the development in total production is shown together with the real US import price for frozen fillets (Norman-López & Asche, 2008). As one can see, the production increased rapidly from 700,000 tonnes in 1995 to over 2.5 million tonnes in 2007. During the same period, the real price declined from about 6 USD/kg to slightly under 3.5 USD/kg, or by more than 40%.

As production increased, some producers also started to export tilapia, with USA as the main market. The share traded internationally is rapidly increasing. Since the turn of the century tilapia has had a significant presence in the largest seafood markets, with as much as one third of production being traded in 2006. In contrast to salmon and shrimp, tilapia markets are highly segmented and diversified. In the US, the largest export market, tilapia markets are diversified; fresh tilapia is produced locally or imported from Latin America, while frozen tilapia is imported from Southeast Asia (primarily China) at significantly lower prices (Norman-López & Asche, 2008).

While better control of the production process, leading to productivity growth, is the main engine for this tremendous growth, tilapia is in many ways still more interesting for what it is not than for what it is, and even more for its potential.[10] A short production time gives tilapia a very high turnover, which is cost reducing as capital utilization improves. The fact that it is not carnivorous makes it likely that it will grow well on feed based primarily or mostly on non-marine ingredients. Inclusion rates of fishmeal are normally low at 5% or less, and availability and cost of fishmeal do accordingly not have a strong impact on the competitiveness of tilapia.[11] In particular, if one believes in higher future price of fish meal and oil due to increased scarcity, inclusion rates and the potential for reduced inclusion are important for future growth potential (Tveterås, 2002). Moreover, tilapia has been the subject of serious large-scale research attention only in the last 15 years, and there is huge potential for further productivity growth, despite the fact that it already is a low-cost species. Finally, little work has been undertaken with respect to creating dependable and cost-efficient international distribution channels. Hence, the species has a tremendous potential to become not only a globally produced but also a globally traded species.

Pangasius

Pangasius is in many ways similar to tilapia. It is a rapidly growing subtropical species with white flesh, low fishmeal inclusion rates in the feed and low production costs. It grows larger than tilapia, and is generally larger when harvested. The larger fillets make it more suitable for many forms of processing. In other ways, the main difference between pangasius and tilapia is the extreme regionalization of production, as pangasius is farmed virtually only in the Mekong delta in Vietnam. This appears to provide some advantages as well as some challenges.

Figure 5 shows the production of pangasius in Vietnam is together with the real export price in USD/kg. As one can see, the production has been rapidly increasing from about 135,000 tonnes in 2002 to one million tonnes in 2007. During the same period, the real price has declined from about 3.50 USD/kg of fillet to about 2.50, a reduction of 40%. Hence, pangasius also appears to follow the pattern of other successful aquaculture species in using price as an important argument for market access.

Tveteras (2002) and Tveteras & Battese (2006) show that there are agglomeration economics in Norwegian salmon aquaculture. The strong regional concentration in pangasius production creates a similar potential in Vietnam. In particular, this seems to be the case at the processing and export levels. An interesting feature of the Vietnamese industry is that there is significant variation in the size of production facilities, while the processing facilities tend to be larger. This implies a significant variation in production practices and degree of control at the farm level, while the processing plants are of a more consistent quality. The scale of the processing plants is also large enough that they can cover the cost of investing in Hazard Analysis and Critical Control Points (HACCP) systems and International Organization for Standardization (ISO) certification as measures to improve confidence in the export market.[12]

The concentration of the industry also appears to have created a number of competent export companies with more efficient distribution and logistics than tilapia. As for tilapia, the Vietnamese exporters first targeted the US market, selling their product as catfish. US catfish farmers did not appreciate this, and US authorities ruled in 2001 that Vietnamese basa and tra could not be sold as catfish. Subsequently, after anti-dumping complaints found Vietnamese exporters guilty in 2003, the US market was made significantly less attractive for Vietnamese exporters, and they targeted other markets, primarily in Europe.[13] In 2008, pangasius was reported to be the most consumed whitefish species in several European countries (Johansen, 2008). Currently, Russia is the largest importer of Vietnamese pangasius despite some trade issues, although the EU is a significantly larger market if we combine all EU member countries. In 2008, the first frozen fillet blocks of pangasius were reported to have arrived in Germany. It is interesting that the fish farmers in Vietnam find this market segment attractive, as it is generally regarded as the lowest value and margin segment in the whitefish market.

Although the concentration of the pangasius industry is likely to have created agglomeration economics in Vietnam, there is little doubt that the limited areas where large quantities of pangasius are produced pose a significant biological risk, including the dissemination of disease. To what extent this will become an issue in the future remains unknown. However, the salmon and shrimp industries also provide clear examples in this respect (Tveterås, 2002; Anderson, 2003).

COMPETITION WITH WILD SPECIES – THE WHITEFISH MARKET

Pangasius and tilapia clearly have the potential to compete in a number of market segments. With white fillets and a neutral taste, it is natural that exporters of these species attempt to win market share from other whitefish species by being marketed as close substitutes. Pangasius and tilapia are highly competitive on price because they exploit many of the advantages with a controlled production process, such as high growth rates and turnover and cheap feed. It is also worthwhile to note that despite being priced relatively low when introduced, the prices of these species also declined when the quantity supplied increased. Hence, these new aquaculture species are certainly winning market share in some established market segments, as well as creating new market segments.

There are a large number of processed product forms in the whitefish market, fore example breaded and battered products, and ready-made meals. With these type of product, it is often very difficult to distinguish between the different species. As the prices of cod and other whitefish species increased and landings decreased during the last few decades, it has become more and more attractive to find cheaper substitutes. This means that cod is, to a much smaller extent, used in lower-valued product forms, like fish fingers.[14] For aquaculture producers of species that are competitive on price, a development where which species one are consuming becomes increasingly irrelevant is an opportunity, as it makes it easier to enter the market. This can make the neutral taste an advantage, as it makes the flesh a versatile carrier of a variety of sauces and spices.

The aquaculture industry targets an increasing number of new market segments, and increasingly higher-volume rather than higher-price segments. Hence, farmed products also win smaller market shares in a number of market segments, as they rapidly enter new segments because of lower prices (Asche, Bjørndal & Young, 2001). This process is also occurring for tilapia and pangasius. For instance, in Europe, pangasius can be found not only as frozen fillets and nonlabeled packages but also as canned products with a variety of sauces, as fresh fillets (refreshed), as prepackaged meals, and in a number of other product forms. Consequently, it is already sold in more product forms than most other whitefish species.

An additional reason why aquaculture species like pangasius and tilapia have an advantage is that the reliable supplies of farmed fish have allowed an increasing degree of standardization in the hotel, restaurant, and catering (HoReCa) sector, and consequently have increased the share of aquaculture products in this particular market segment. This development was led by salmon, catfish (in the US), and shrimp, but more recently, an increasing number of new species like tilapia and pangasius have appeared on menus.

CONCLUDING REMARKS

That the seafood market is highly segmented with a number of different species is well known (Asche, Bjørndal & Young, 2001; Anderson, 2003). This can be interpreted as evidence that consumers have varying preferences for different types of seafood. This also seems reasonable, as different species have different characteristics, and no chef would consider using the same recipe for salmon, mussels and pangasius. However, globalization and trade also create competition between new species as markets are linked. This is apparent in the whitefish market, where new wild species, like Alaskan pollock and hoki and aquaculture species, have recently had a significant impact.

The whitefish market is likely to continue to grow as new species are introduced into the market. Aquaculture species play an important role in this development as production increases and productivity continues to improve. The whitefish market will then be attractive for aquaculture producers, partly because it is easier to enter existing market segments than to create new segments, and partly because it is difficult to build consumer loyalty with nonlocal species with which consumers are not familiar.[15]

Figure 6 shows the significant impact of aquaculture on the seafood market in the US, with the per capita consumption of the six most consumed species in 2006. Consumption of traditional wild species, like tuna and Alaska pollock, is stagnant or declining, while consumption of (primarily) farmed species like shrimp and salmon is rapidly increasing. The effect of tilapia is particularly profound, as the species was not on the top-ten list in 2000. American catfish appears to be in an intermediate position, as it is an aquaculture species, but consumption has stagnated during the last few years. Traditional species, like cod and flounder, are no longer included among the top six most consumed species.

The transformation that aquaculture species will cause in most seafood markets has most likely only just begun. For salmon, the production cost in aquaculture started determining the price of wild salmon in the late 1980s (Asche, Bjørndal & Young, 2001). The US anti-dumping suits make the same argument with respect to shrimp (Keithly & Poudel, 2008), although the evidence is not equally clear. As aquaculture production continues to increase, one is likely to observe this situation for an increasing number of fish species. With increased supply and market share from aquaculture, production cost for the farmed species will become increasingly important in the price determination process until, like for salmon, it completely determines the long-run development of the price. With pangasius and tilapia this process is well on its way in the whitefish market.

The main engine for the increased production in aquaculture is control of the production process, as this leads to productivity growth, lower production costs and more competitive products (Asche, 2008). Furthermore, control of the production process allows for more efficient logistics, distribution, and marketing (Asche, Roll & Tveteras, 2007). The technological frontiers in production, transport, and marketing are set to continue to improve. However, even with limited technological development at the frontier, there is a huge potential for productivity growth for most species, as the production processes for few species currently use most of the available knowledge.[16] This advantage is for many aquaculture species amplified by productivity growth in the supply chain and market growth.

While pangasius and tilapia have changed seafood markets in Europe and the USA during the last decade, they are likely only the first of a number of species that will follow a similar development pattern. A number of countries are already producing tilapia, but it can be produced in many more. Are there other species out there with a similar potential? Alternatively, are there species, like pangasius in Vietnam, that are well adapted to the local environment and difficult to distinguish from other whitefish fillets when they reach the international market? A number of fish species are candidates, including barramundi, grouper, and the olive flounder.

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Table 1. Percentage production share by region

Region	Quantity	Value
Asia	92.0	79.6
Americas	3.3	9.8
Europe	3.2	8.2
Africa	1.1	1.6
Oceania	0.2	0.9

Source: FAO (2008).

Table 2. Aquaculture production by species, thousands of tonnes, 2006

Species	Quantity	Percent
Carps, barbels and other cyprinids	20,526	40 %
Freshwater fishes	4,916	10 %
Oysters	4,714	9 %
Clams, cockles, arkshells	4,310	8 %
Shrimps, prawns	3,164	6 %
Tilapias and other cichlids	2,326	5 %
Salmons, trouts, smelts	2,143	4 %
Scallops, pectens	1,890	4 %
Scallops, pectens	1,408	3 %
Marine molluscs	1,256	100

Source: FAO (2008).

Table 3. Aquaculture production by species, millions USD, 2006

Species	Value	Percent
Carps, barbels and other cyprinids	18838	24 %
Shrimps, prawns	12486	16 %
Salmons, trouts, smelts	9892	13 %
Miscellaneous freshwater fishes	7932	10 %
Freshwater crustaceans	4715	6 %
Clams, cockles, arkshells	4054	5 %
Oysters	3188	4 %
Miscellaneous coastal fishes	3083	4 %
Tilapias and other cichlids	2777	4 %
Scallops, pectens	2159	3 %
Total	78737	

Source: FAO (2008).

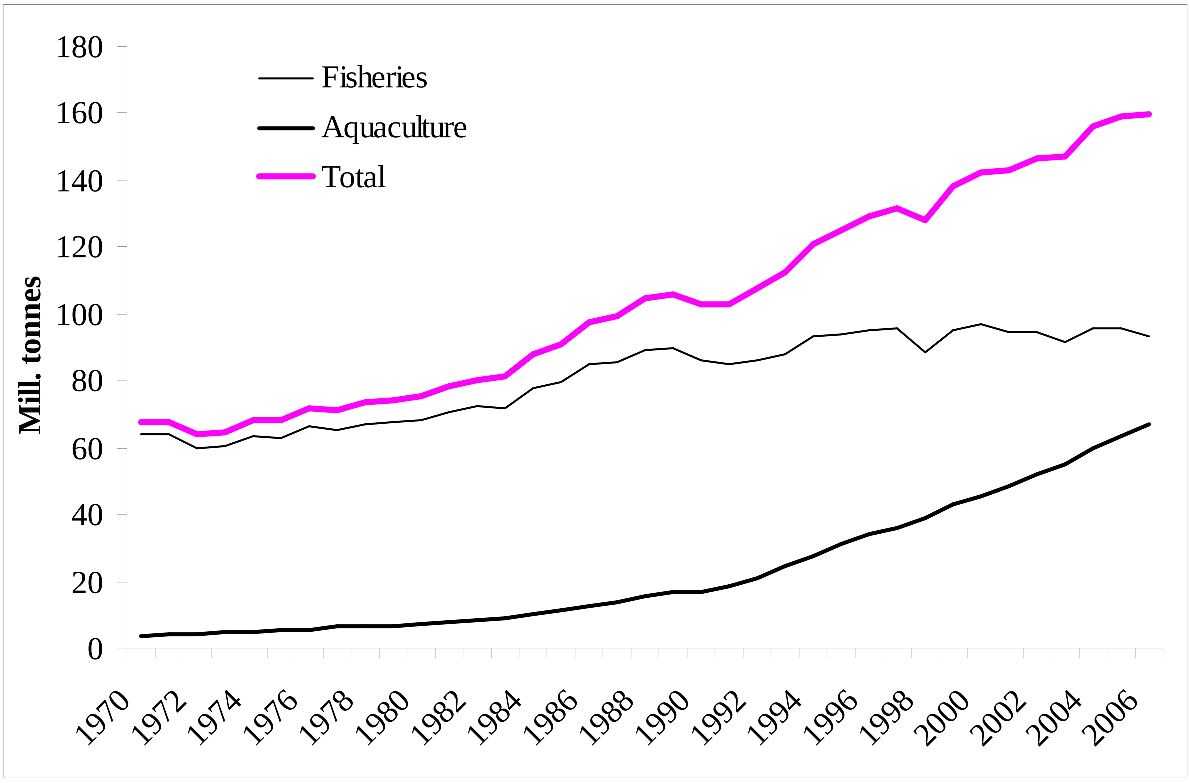

Figure 1. Global production of seafood, millions of tonnes, 1970–2006

Source: FAO

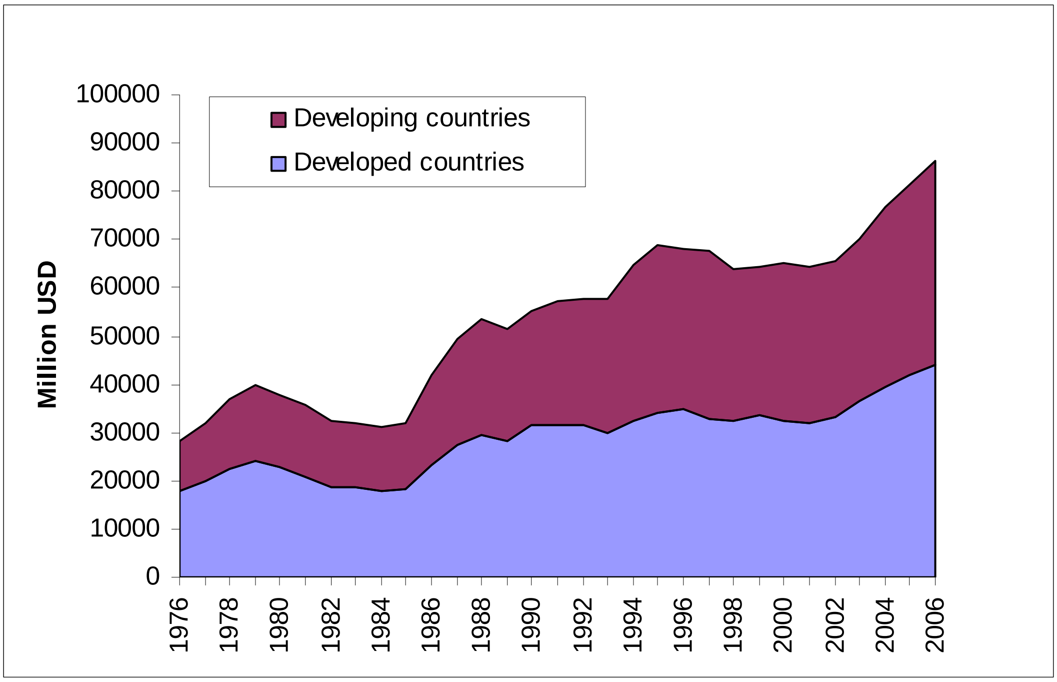

Figure 2. Real world trade value, exports (2006 = 100)

Source: FAO

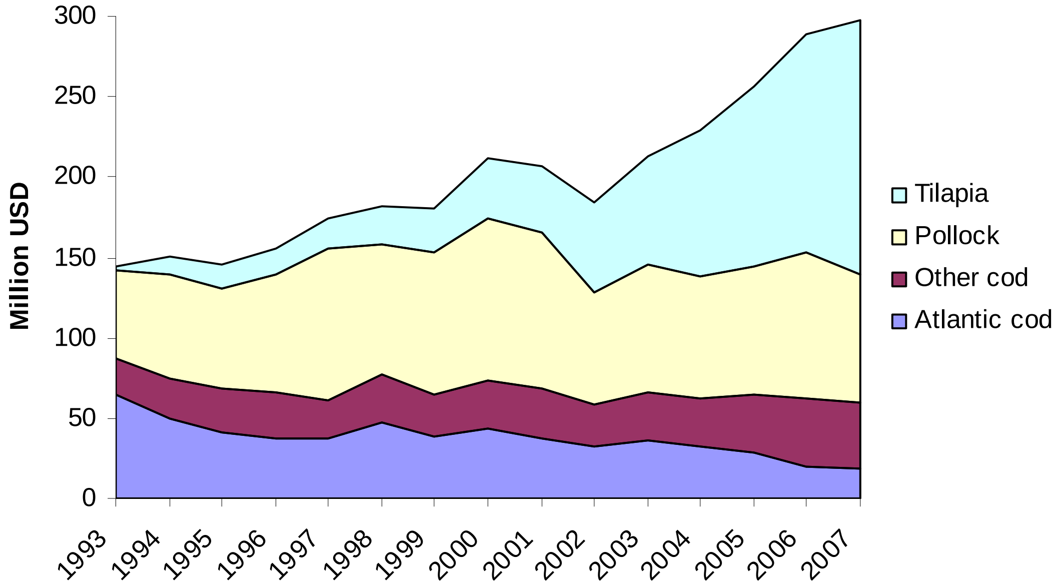

Figure 3. Annual US import value of Atlantic cod, other cod, pollock and tilapia

Source: NMFS

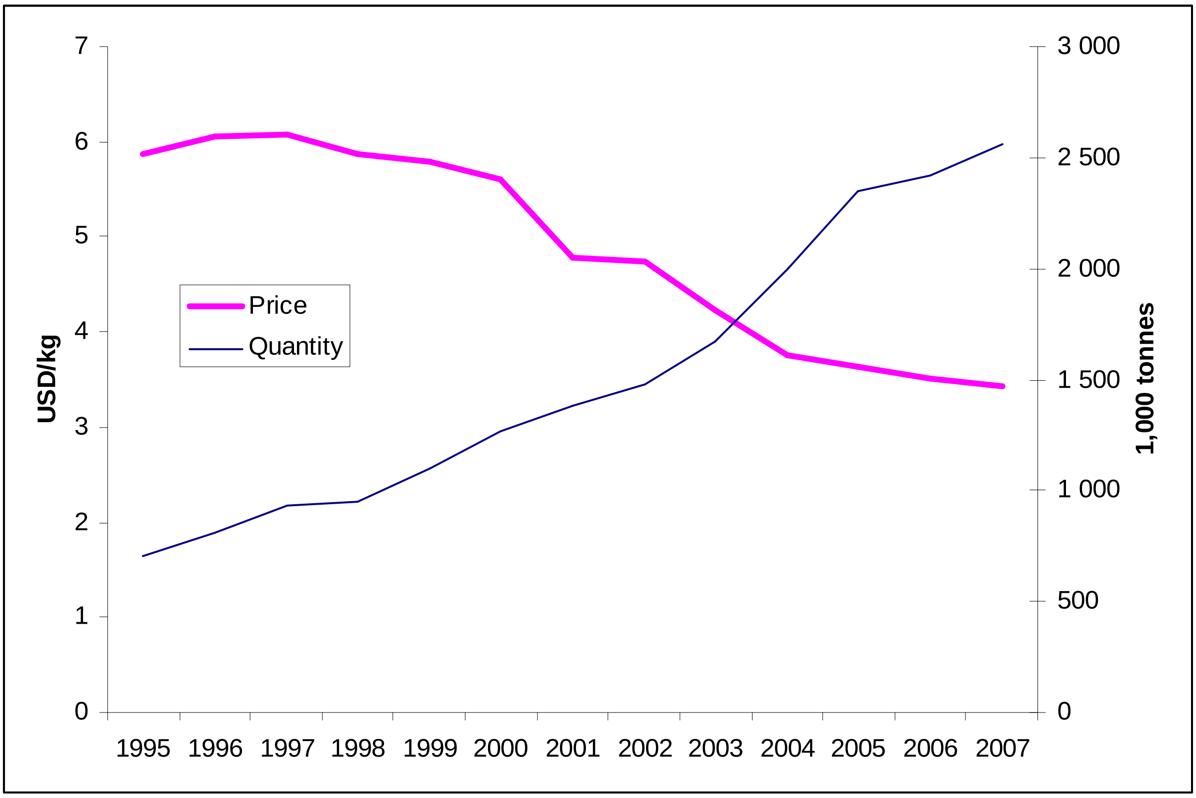

Figure 4. Global tilapia production and real US import price for frozen fillets

Source: FAO, NMFS

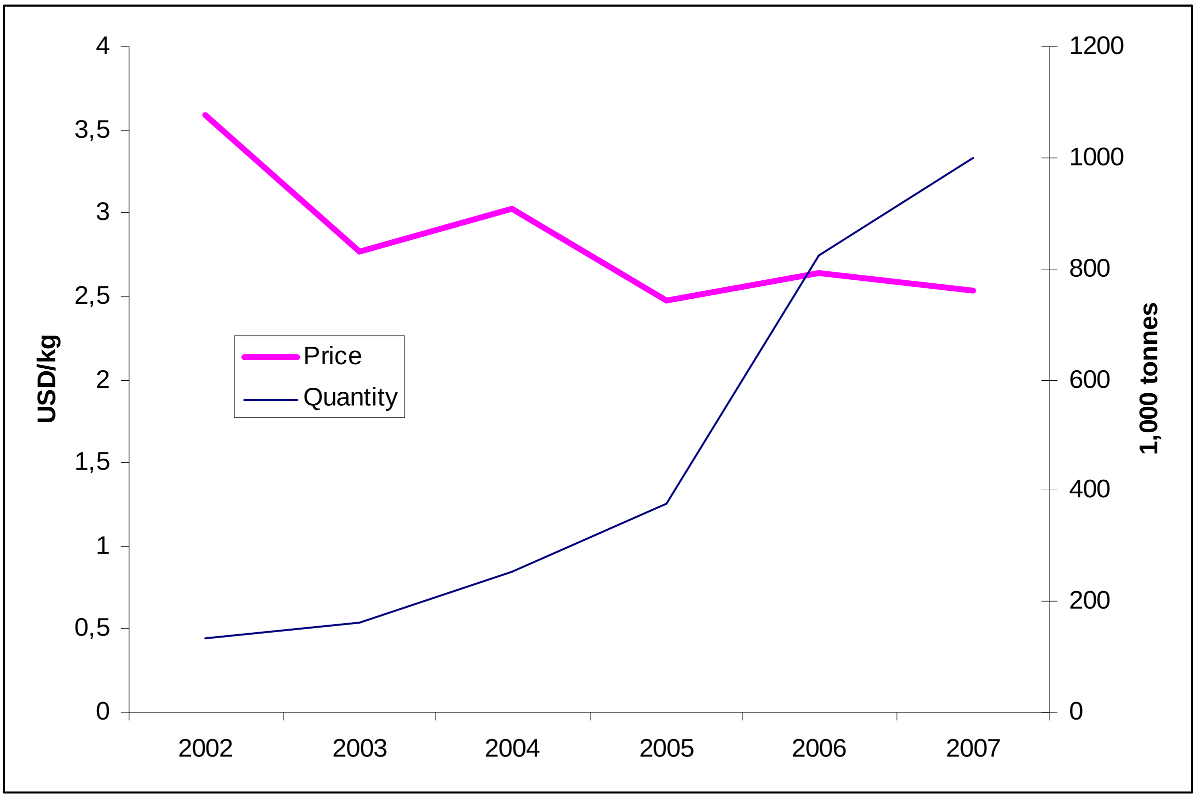

Figure 5. Pangasius production and real US export price for frozen fillets

Source: FAO, NMFS

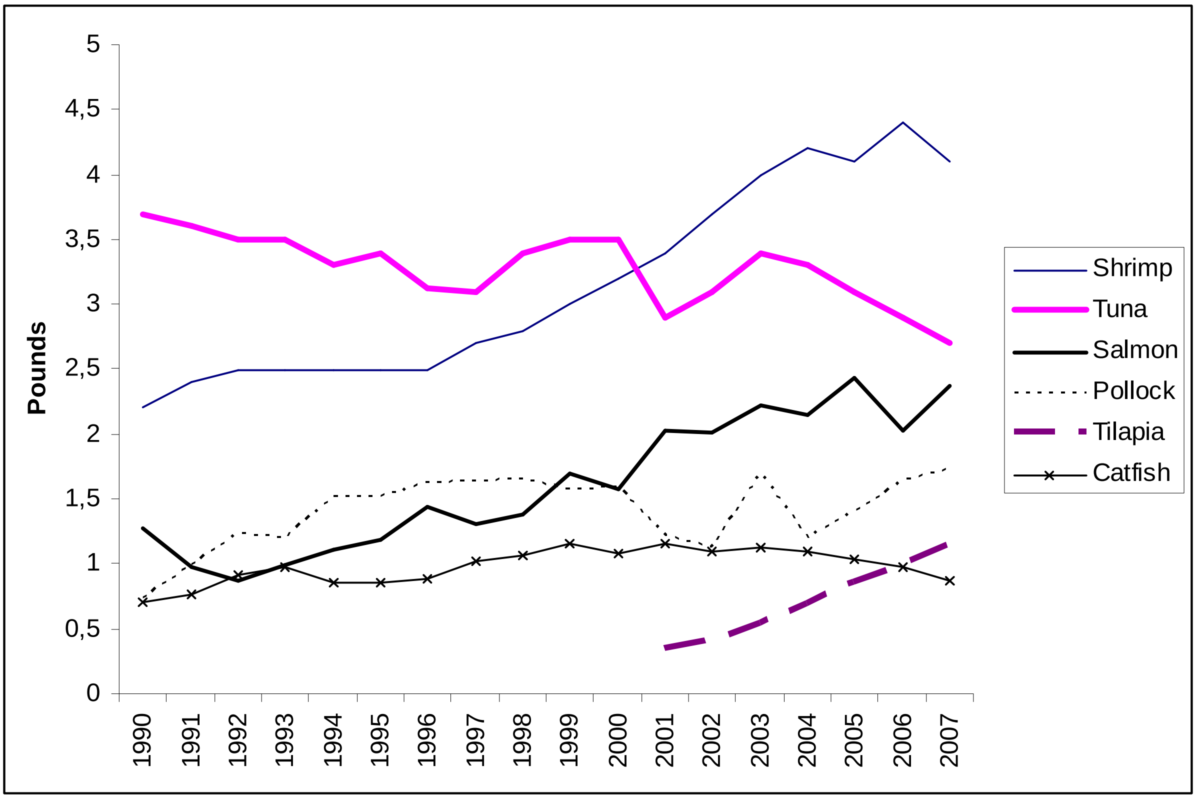

Figure 6. US per capita consumption of the six most consumed species

Source: National Fisheries Institute

Footnotes

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[1] Of course, market growth can reduce—and in special cases, reverse—the speed of movement downwards along the demand schedule.

[2] This larger market may comprise wild landings of the same species and other potential substitutes.

[3] Strictly speaking, pangasius is two different species from the same family, basa and tra. In most cases, they are marketed as pangasius, and we therefore use this term here.

[4] Anderson (2003) provides a thorough review of the international seafood trade and the most important species.

[5] We should note that export quantities are not directly comparable to production quantities as exports are measured in product weight. This can lead to dramatic differences as the fillet weight of, for instance, tilapia is only between 30% and 40% of the harvest weight. As such, when the traded quantity is about 30 million tonnes product weight and the total production quantity is about 150 million tonnes live weight, we can conclude that the traded quantity is at least 20%, but most likely significantly higher as a significant share of the trade is in processed products. The final figure is probably between 30% and 40% of total production.

[6] The international market is even larger as seafood trade also significantly influences many domestic markets, as local fishermen and fish farmers are exposed to the competition from imports and thereby become a part of the international market.

[7] Keithly & Poudel (2008) provide an interesting discussion of shrimp in the USA, and Kinnucan & Myrland (2002) discuss trade conflicts related to salmon in the EU.

[8] This process also provides further links between the whitefish market and other markets, as many of these species have alternative markets where they have traditionally been sold.

[9] Breeding is undertaken by organizations (such as Worldfish) and by public entities and publicly supported companies. Dey et al. (2000) discuss the Worldfish effort.

[10] Young & Muir (2002) provide an interesting discussion of the competitive advantages of tilapia on both the production and market sides.

[11] It is worthwhile to note that this rate is significantly lower than salmon and shrimp, where fishmeal typically makes up about 30% of commercial feed. It is also significantly lower than for coldwater whitefish like cod.

[12] Jan & Liao (2006) provide a discussion of the importance of HACCP in Taiwan.

[13] The high degree of concentration may have amplified the trade conflicts that Vietnamese exporters have experienced, as it makes it easier for plaintiffs to pinpoint their complaints.

[14] Roheim, Gardiner & Asche (2007) discuss how the value of fish products varies with product forms and attributes.

[15] As it is easier to enter existing market segments, one is also likely to see an increasing number of cases where exporters give their species a name that is similar to an existing species in the market, as found with pangasius labeled as catfish in the US.

[16] Sharma & Leung (2003) provide a review of the potential for efficiency gains by improving technology to best practice.