# Report on the determinants of the social, environmental and economic impact of food quality schemes on food chains and rural areas based on cross-case analysis

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Strengthening European Food Chain Sustainability by Quality and Procurement Policy

**Deliverable 5.3:**

# REPORT ON THE DETERMINANTS OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT OF FQS ON FOOD CHAINS AND RURAL AREAS BASED ON CROSS-CASE ANALYSIS

**February 2019**

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The economic, environmental and social sustainability performance of food quality schemes (FQS) is found to be higher than for equivalent reference products for many indicators. The median values are typically positive. For almost all indicators, the FQSs do not perform substantially worse than their reference. The two notable exceptions are exports and green water footprint, both of which are viewed by several stakeholders as not necessarily relevant as performance indicators. Indeed, although exports may be a means of diversifying markets and improving resilience, a diversity of markets can typically be achieved nationally. The green water footprint reflects the total consumption of water, which is mostly rainwater, and as such is only relevant in regions where rainwater scarcity is a concern.

FQSs generally perform well in terms of classical economic indicators (price, value added and margins). Environmentally, FQSs perform particularly well in terms of lower carbon footprint per hectare and lower distance travelled by products. On social aspects, FQSs perform better on all indicators pertaining to employment, on the equity of bargaining power between value chain levels, and on generational renewal.

In some cases, technical specifications are a key driver of performance: for example, in many PDOs, the specification of a production area limits the distances between farms and processing plants, reducing *food-miles*. The specific governance of GIs also directly improves bargaining power in several cases. Finally, the specific terroir of GIs can also be a driver of performance: leading to higher or lower yield than reference products. Thus pedo-climatic characteristics play an important role in explaining differences in carbon and water footprints.

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| PDO | Protected Designation of Origin |
| PGI | Protected Geographical Indication |
| FQS | Food Quality Scheme |
| REF | Reference product |
| LCA | Life Cycle Assessment |
| GOM | Gross operating margin |

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# 1. SYNTHESIS

## 1.1. Overview

The economic, environmental and social sustainability performance of food quality schemes (FQS) is found to be higher than their reference product for many indicators (Figure 1). The median values are often positive. For almost all indicators, the FQSs do not perform substantially worse than their reference. The two notable exceptions are exports and green water footprint, both of which are viewed by several stakeholders as not necessarily relevant as performance indicators. Indeed, although exports are a means for diversifying markets and improving resilience, a diversity of markets can often be achieved nationally. Green water footprint reflects the total consumption of water, which is mostly rainwater, and as such is mostly relevant in regions where rainwater scarcity is a concern.

FQSs appear to be superior in terms of classical economic indicators (price, value added and margin). Environmentally, FQSs perform particularly well in terms of lower carbon footprint per hectare and lower distance travelled by products. On social aspects, FQSs perform better on all indicators pertaining to employment, on the equity of bargaining power between value chain levels, and generational renewal.

**Figure 1. Economic, environmental and social sustainability performance of food quality schemes**

For example, the second line reads as follows: gross value-added could be estimated in 22 out of 27 case studies. The median difference in price between FQSs and their reference products is +12%, varying between -250% and +113%. The gross value added of the FQS is substantially better than its reference (difference > 10%) in 55%, and not substantially worse than its reference (difference > -10%) in 82% of cases. Most indicators are averaged between levels of the supply chain before being compared with the exception of environmental indicators. For environmental indicators, the value adding up the environmental impact down to the lower relevant level (mostly processing for carbon and water and retail for food-miles) is retained. Similar tables per FQS and per sector are provided in Annex 1.

| Indicator name | Cases with indicator | Median difference | Min / Max difference | Share of cases with difference > 10% | Share of cases with difference > -10% |
|---|---|---|---|---|---|
| Price | 25 / 27 | 64% | [15% - 362%] | 100% | 100% |
| Gross value-added | 22 / 27 | 12% | [-250% - 113%] | 55% | 82% |
| Share of value exported within Europe | 15 / 27 | -59% | [-100% - 510411%] | 33% | 47% |
| Gross operating margin | 22 / 27 | 26% | [-82% - 268%] | 77% | 86% |
| Net result | 7 / 27 | 117% | [-11% - 447%] | 71% | 86% |
| Share of value exported outside Europe | 14 / 27 | -78% | [-100% - 459%] | 21% | 36% |
| Share of volume exported within Europe | 22 / 27 | -31% | [-100% - 13588%] | 36% | 45% |
| Share of volume exported outside Europe | 20 / 27 | -68% | [-100% - 799%] | 30% | 40% |
| Carbon footprint of product | 25 / 27 | 5% | [-85% - 51%] | 40% | 56% |
| Carbon footprint of area | 23 / 27 | 29% | [-26% - 71%] | 78% | 91% |
| Distance traveled | 24 / 27 | 20% | [-270% - 100%] | 67% | 92% |
| Carbon emissions related to the transportation stage | 24 / 27 | 11% | [-270% - 100%] | 50% | 83% |
| Green water footprint (net consumption of water) | 21 / 27 | -22% | [-159% - 55%] | 19% | 33% |
| Grey water footprint (water pollution) | 21 / 27 | 3% | [-118% - 98%] | 43% | 62% |
| Blue water footprint (gross consumption of water) | 21 / 27 | 16% | [-217547% - 95%] | 52% | 62% |
| Labour-to-production ratio | 25 / 27 | 19% | [-86% - 1536%] | 60% | 72% |
| Turnover-to-labour ratio | 24 / 27 | 17% | [-89% - 315%] | 54% | 71% |
| Bargaining power distribution | 15 / 27 | 56% | [-150% - 100%] | 67% | 73% |
| Educational attainment | 23 / 27 | 0% | [-75% - 176%] | 30% | 78% |
| Wage level | 22 / 27 | 26% | [-72% - 2673%] | 64% | 91% |
| Generational change | 22 / 27 | 18% | [-92% - 276%] | 55% | 77% |
| Gender equality | 22 / 27 | 0% | [-709% - 38%] | 9% | 73% |
| Gender equality index | 19 / 27 | -2% | [-303% - 99%] | 26% | 53% |

## 1.1. Economic indicators

### *1.1.1. Elements on profitability*

Price and gross operating margin are significantly higher for FQSs. It is higher for organic products than for PGI and PDO products. At upstream level, the profitability of organic products is also higher.

The price premium is equally distributed over the value chain, around 60-70% at all levels. The difference in gross operating margin between FQSs and their reference is however more important – expressed as a percentage of turnover – at farm level than at processing level.

FQSs are often more oriented towards regional or national markets than their reference products, although a few FQS have an international recognition (e.g. Parmigiano Reggiano, Lofoten stockfish) and are therefore more exported than their reference.

Price premium and profitability are not perfectly correlated: analysing economic sustainability of FQS requires taking into account the balance between price premium and additional costs due to meet specific requirements of FQS.

Net results often could not be estimated due to the lack of rigorous accountancy data or the difficulty to access it for more than a few firms.

### *1.1.2. Local multiplier*

There is not much difference between FQS and reference, especially for vegetal products. This is likely related to the fact that transportation costs are high for raw materials, in particular for animal products, which pushes processing plants to source their feedstock locally even for reference products.

The core input is the most important determinant of the local multiplier. Accordingly, for those value chains where it is not locally sourced (e.g. pork meat for PGI Gyulai sausage and PGI Dalmatian ham, wheat for French organic flour), sourcing it locally would be the most effective change to improve the local economic spillover of the FQS.

## 1.2. Environmental indicators

### *1.2.1. Carbon and land footprint*

As for conventional food products, most of the greenhouse gas emissions of FQS occur before the farm gate, with the only exception of unfed fish and seafood products. In terms of carbon footprint per hectare, 83% of FQS perform substantially better than their reference. Correspondingly, the land footprint of FQS is substantially higher in 74% of cases, indicating that FQS require more land per unit of product.

In terms of carbon footprint per ton of product, the picture is mixed. The median difference is close to zero and only 42% of the cases substantially improve upon their reference. The comparison is however more favourable to FQSs when it is performed at the level of original products (e.g. milk for cheese, wheat for flour): more than two third of FQSs are not substantially worse than their reference at farm level.

There is no clear-cut difference in carbon footprint per ton of final products between the different categories with the only exception being products that are both vegetal and organic. Indeed, all these products have a substantially lower carbon footprint than their reference.

The key drivers of a lower carbon footprint include optimized or absence of fertilizer use, high processing efficiency (units of raw product needed per unit of final product), high feed-to-food conversion efficiency of the herd in animal cases and high yield. These are in turns positively influenced by the technical specifications of FQS in several cases. The physical characteristics of the terroir of some GIs also influence yield, positively or negatively.

### *1.2.2. Food-miles*

80% of distances and emissions from the transport stage occur after the processing plant, the main contribution being that of exports. FQS products embed less transportation than their reference: the median difference is 26% shorter, with three fourth of the cases substantially improving upon their reference and only 8% are substantially underperforming. As a consequence, $CO_2$ emissions from transportation are also lower for FQS: the median difference shows that emissions are 20% lower, with 56% of the cases substantially improving upon their reference and 80% not substantially worse.

The larger the share of exports in total production and the larger the share of extra European exports in total exports, the longer the distances, but not necessarily the higher the emissions: most oversea exports rely on sea transport, a low-carbon transportation mode that lower the carbon content per km travelled. The larger the share of imports of raw products and the more concentrated the product, the longer the distances and the higher the emissions.

PDO technical specifications delimit a geographical area for production and processing, therefore limiting distances and emissions

#### *1.2.3. Water footprint*

The water footprint results highlight that water consumption is in general mainly due to the agricultural phase. The processing phase produces impacts that for the most part of the products are not comparable with that of the agricultural (in farm) phase.

Groundwater and surface water consumption (blue water footprint) is lower in FQS than for their reference products in 14 out of 22 cases. For water pollution by nitrogen (grey water footprint), the picture is rather balances with a better performance of FQS in 12 out of 22 cases. For total water consumption including the possibly irrelevant rainwater consumption (green water footprint), non-certified products perform better than FQS in 17 out of 22 cases.

However, all these indicators are expressed on a per ton basis, whereas the impact on water has a strong local component. When organic farming is subsidized close to water catchments, policy makers aim at a lower grey water footprint on a per hectare basis. Indicators on a per hectare basis should therefore be investigated together with their per ton counterparts in future studies.

### 1.3. Social indicators

#### *1.3.1. Employment and skills*

On most employment-related indicators, the FQS perform better than their reference. They provide more employment per ton of product while ensuring a higher turnover per working unit. More and smaller firms, reducing possible economies of scale, as well as labour intensive standards, seem to be driving the higher need for labour per ton while the price premium of FQS products largely drives the higher turnover per working unit.

Concerning workforce skills and social capital, the picture is more mixed. FQS tend to offer higher wages to their workers, particularly at processing level. In some cases, this is related to more technical processes. However, no difference is found on the educational attainment of the workforce.

#### *1.3.2. Bargaining power and its distribution*

FQS value chains exhibit a more evenly distributed and a more stable bargaining power, which should allow them to better cope with substantial changes that may affect the supply chain. When it comes to the sources of this advantage, the richness of the supply chains' institutional environment (ie the capacity to act collectively and to regulate individual behaviours through collective rules) is key. Also important is actors' capacity to contribute to the specificity of the end-product and to mobilize specific resources in this process, while, on the other hand, the characteristics of the competitive environment doesn't play a substantial role.

#### *1.3.3. Generational and gender balance*

Generation renewal is slightly more sustainable for FQS. This is particularly true for organic value chains or at processing level. In absolute terms however, generational renewal remains an issue in most agricultural value chains, be they FQS or not. Female workers and entrepreneurs are also underrepresented in most value chains, and this gender inequality is similar between FQS value chains and their references.

# 2. ECONOMIC IMPACT OF FQS AND ITS DETERMINANTS

## 2.1. Elements on profitability

The indicators picked out to conduct the analysis are:

- the price premium (using the reference product as benchmark)
  $PP^i = \frac{P^i_{FQS} - P^i_{Ref}}{P^i_{Ref}}$ , with: P = price; i refers to the product (i=1, 27)
- the gross operating margin (GOM), which allow to compare the profitability of FQS and reference products. This indicator integrates most of the relevant production costs (intermediate consumptions, wages and subsidies), which capture main differences between FQS and reference products regarding profitability. GOM and costs are expressed as a percentage of turnover.
- the exports (volume or value) distinguishing the destination (countries of the European Union or not). It is a question of whether SIQOs impact on the export competitiveness.

Expressing indictors as percentage makes possible the comparison between case studies and the aggregation of results obtained for each case.

The number of cases for which the available information allowed for estimating these indicators varies between 2 and 25 out of 29 cases (Table 1). PP, GVA and GOM could be estimated in most cases at farm and processing levels. At downstream level (distribution and retail), only price was available in most cases. Indeed, in most value chains, downstream firms are not specific of the value chains as defined in Bellassen et al. (2016). The net result was also difficult to obtain in many cases due to the lack of information on financial costs and provisions for depreciation.

**Table 1. Total of observations available for each indicator at the different supply chain levels**

| | Upstream | Processing | Downstream |
|---|---|---|---|
| **PP** | 25 | 23 | 22 |
| **GVA** | 22 | 17 | 3 |
| **GOM** | 22 | 17 | 2 |
| **Net Result** | 6 | 6 | 2 |
| **Export in volume (and in value)** | / | / | 22 (16) |

### *2.1.1. Results*

#### 2.1.1.1. Prices paid for FQS is higher all along the chain

In total 70 PPs have been calculated together with their distribution along the production levels (Table 2).

**Table 2. Price premium generated by FQS at different levels**

| ***Price Premium*** | | **Mean (Std dev)** | **Median** | **# observations** |
|---|---|---|---|---|
| *Total* | | 0.75 (0.85) | 0.61 | 70 |
| *By supply chain level* | Upstream | 0.70 (0.79) | 0.62 | 25 |
| | Processing | 0.79 (0.79) | 0.61 | 23 |
| | Downstream | 0.77 (1.01) | 0.53 | 22 |

Performing the Kruskal-Wallis rank test by level (Table 3), we conclude that the 3 samples are from the same population. This result indicates no difference in term of price premium generated by FQS along the value chain. They are all around 60-70%.

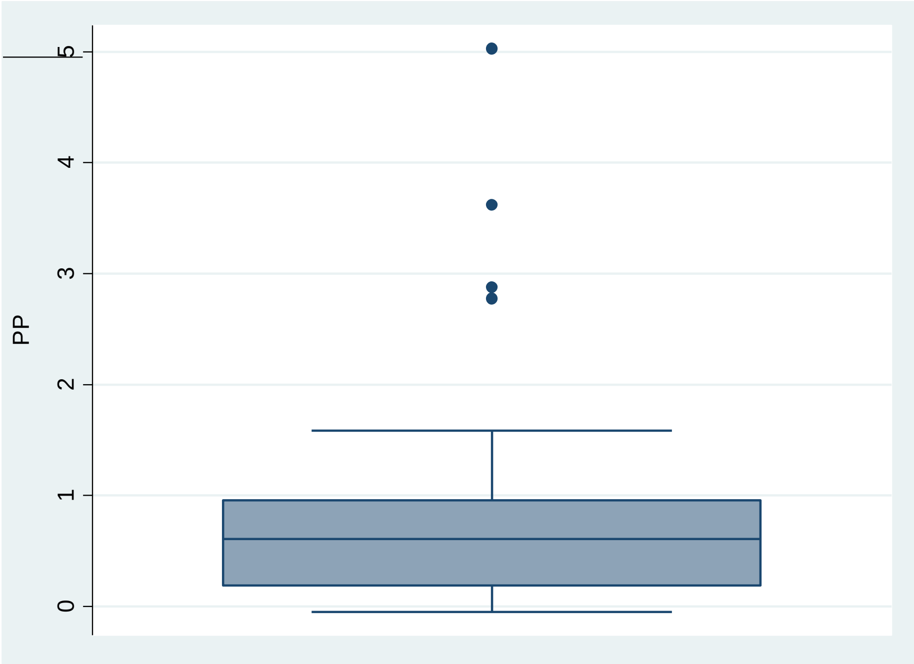
**Table 3. Kruskal-Wallis equality-of-populations rank test**

| *level* | *Obs* | *Rank sum* |
|---|---|---|
| *upstream* | 25 | 843.50 |
| *processing* | 23 | 834.50 |
| *downstream* | 22 | 807.00 |

*chi-squared = 0.295 with 2 d.f.*
*probability = 0.8628*

The distribution of PP is illustrated by the following box plot (Figure 2).

**Figure 2. Distribution of price premium**




Four PP can be viewed as outliers:

- 277% for Polish Organic pasta at processing level,
- 287% for Lofoten Stockfish, at processing level,
- 361% for Opperdoezer Ronde potato at upstream level,
- and 502% for Polish Organic pasta at upstream level.

These PP outlier cases are FQS characterized by small production volumes, which are compared with commodity type reference products, with low prices due to high volumes of production and low level of differentiation (potatoes, salt fish and pasta in those cases). Thereafter the PP statistical analysis is conducted without these four observations (n = 70 – 4 = 66).

Only two price premium are negative: PGI Norwegian Stockfish at upstream level (-1%) and PGI Croatian ham at upstream level (-4%). Nevertheless, these values are very small and not significant. For Croatian ham, the technical specifications do not cover the farm level, as in many PGIs. For Stockfish, technical specifications limit the fishing area, but this does not impact fishing costs.

The main result from the price premium (PP) analysis is that regardless of the production level, the kind of FQS and the kind of product (animal, vegetal or seafood), price is higher for FQS than for the reference product, at upstream, processing and downstream level.

The dispersion of PP is of course reduced, excluding outliers, but remains high. The highest dispersion is observed at upstream level.

#### 2.1.1.2. Organic products have the highest price premium

Quality schemes differ in terms of quality differentiation and in their ability to match with consumer expectations. We suppose that this situation may influence the level of price premium they generate (Table 4).

**Table 4. Price premium generated by FQS according type of FQS**

| *Price Premium* | | Mean (Std dev) | Median | # observations |
|---|---|---|---|---|
| *FQS* | PGI | 0.47 (0.44) | 0.28 | 20 |
| | PDO | 0.55 (0.44) | 0.46 | 25 |
| | Organic | 0.73 (0.47) | 0.68 | 21 |

The Kruskal-Wallis rank test performed by FQS does not allow concluding that the 3 samples are from the same distribution (P value =0.86). To compare samples two by two, we conduct Wilcoxon tests and we test the equality of median by pair of FQS (Table 5).

**Table 5. Comparison between PP generated by different type of FQS**

| FQS | | # Obs | Same population (P value\|) | Same median (P value\|) |
|---|---|---|---|---|
| **PGI & PDO** | PGI | 20 | Yes (0.38) | Yes (0.64) |
| | PDO | 25 | | |
| **PGI & Organic** | PGI | 20 | No (0.056) | No (0.08) |
| | Organic | 21 | | |
| **PDO & Organic** | PDO | 25 | Difficult to conclude (0.19) | No (0.14) |
| | Organic | 21 | | |

According to these tests we conclude that PP for organic products is significantly higher than for PGI products. The situation is less clear for PDO from a statistical point of view. Nevertheless data observation indicates that PDO products tend to have better PP than PGI ones, especially considering processing level.

#### 2.1.1.3. No significant differences of price premium between sectors

Price premium may be more or less important depending on the different sectors (vegetal, animal or sea food/fish). We present statistical results on price premium for the three sectors (Table 6).

**Table 6. Price premium generated by FQS according production sectors**

| *Price Premium* | | Mean (Std dev) | Median | # observations |
|---|---|---|---|---|
| *Products* | Vegetal | 0.65 (0.49) | 0.62 | 31 |
| | Animal | 0.55 (0.44) | 0.50 | 23 |
| | Sea food | 0.48 (0.41) | 0.37 | 12 |

The Kruskal-Wallis rank test performed by product allows concluding that the 3 samples are from the same population. The test of equality of medians concludes that median do not differ according to sectors. The high dispersion of PP indicators can explain these results, even if average and median look somehow different.

#### 2.1.1.4. Gross operating margin are often higher for FQS production

GOM includes the most important production costs, directly assignable to production process. This indicator is available at upstream level for 22 products and at processing level for 17 products (see Table 7). Data are available for only 2 products at downstream level, but we consider that at this level that comparing FQS and a reference would not be relevant for our analyses.

**Table 7. Gross operating margin differential (ΔGOM) for FQS at different levels**

| ΔGOM | | Mean (Std dev) | Median | # observations |
|---|---|---|---|---|
| **Total** | | 9.9 (19.6) | 5 | 39 |
| **Production level** | Upstream | 12.8 (23) | 7.5 | 22 |
| | Processing | 6.2 (12.7) | 5.7 | 17 |

We summarize data on ΔGOM in Figure 3. Outliers at upstream level are Fal oysters[1] (ΔGOM=-23) and Sjenica cheese (ΔGOM= 101). Outliers at processing level are Gyulai sausage (ΔGOM= -8), Kastoria apple (ΔGOM=15), Organic salmon (ΔGOM=27) and Zagora apple (GOM=45).

[1] PDO Fal Oyster case suffers from its very small size even in the PDO area, and the PDO is facing several problems and uncertainties concerning its future. Indicators from this case should be treated with caution.

**Figure 3. Boxplot on GOM differential at upstream and processing level**

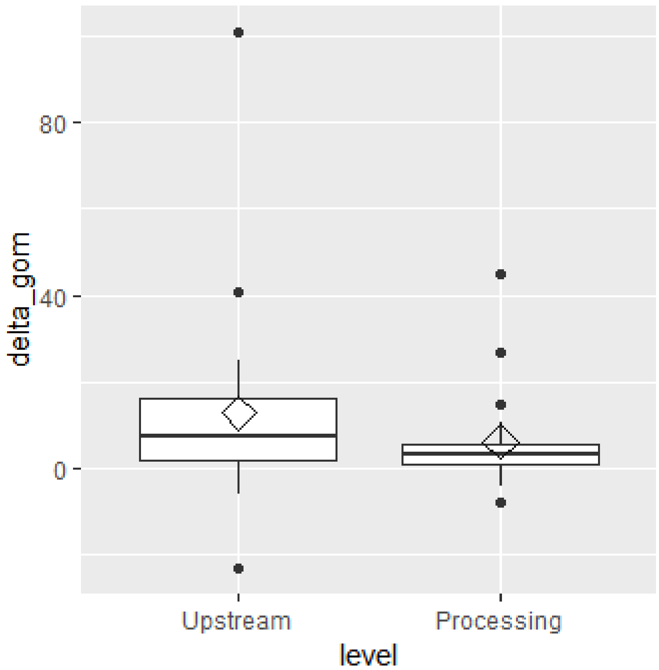



**Table 8. Gross operating margin differential (ΔGOM) for FQS at different levels without outliers**

| ΔGOM | | Mean (Std dev) | Median | # observations |
|---|---|---|---|---|
| **Total** | | 7.02 (9.9) | 4.45 | 33 |
| **Production level** | Upstream | 10.2 (11.4) | 7.5 | 20 |
| | Processing | 2.1 (3.9) | 1.4 | 13 |

Using the Wilcoxon rank-sum test, we conclude that the difference in GOM between FQS product and reference product (ΔGOM) does not follow the same distribution whether outliers are taken into account or not (P value=0.11 with outliers; P value=0.015 without outliers), at upstream level and processing level, with different median (P value=0.034 with outliers; P value=0.02 without outliers). We conclude that the impact of FQS in the profitability of production is significantly higher at upstream than at processing level.

The difference in ΔGOM between upstream and processing levels partially comes from subsidies received by some productions at upstream level. The dispersion of ΔGOM at upstream level is linked with the dispersion of subsidies. The correlation between these 2 variables is 0.89.

Relative profitability is lower for FQS in 4/22 cases at upstream level and 4/17 cases at processing level, with 2 cases having negative results at both level. This does not mean that those FQS have a lower profitability in absolute value. GOM could be higher in value but lower when expressed as a percentage of turnover. A negative ΔGOM means that the FQS production does not allow extracting a higher share of value from turnover for the production/processing unit. This is the case when intermediate costs and wages represent a higher share of turnover for FQS than for reference products, without being fully compensated by subsidies and price premium.

As in most cases ΔGOM is positive, both at upstream and processing level, we can conclude that FQS allow in general a better profitability, i.e. better return share for producers and processors, than reference products. Since samples in terms of FQS are very small, we propose to characterize different groups of FQS along two dimensions: price premium and ΔGOM.

#### 2.1.1.5. Organic FQS tend to perform better economically than other FQS

Figure 4 and Figure 5 represent price premium and profitability differential (ΔGOM) at upstream and processing levels. As we mentioned, price premium is above zero, and most case studies exhibit a positive ΔGOM. We also use medians to identify 4 different groups.

The upper right quadrant includes cases with high level of PP and ΔGOM. At upstream level, most organic products appear in this group, showing a trend of organic to perform better in term of price premium and profitability than other FQS.

At the opposite, the lower left quadrant includes the less performing. No general trends appear in terms of sector or FQS. But we notice that considering lower left and right quadrants, all the PGIs are clustered: they have a lower price premium, but some of them perform better than median in term of profitability, and other less. It confirms that it is not enough to deal with price premium to check for economic performance of FQS, but rather to include also indicators balancing costs and benefits like GOM.

Finally, the upper left quadrant corresponds to cases with relatively high level of PP but low profitability, even sometimes lower than reference products. These productions are characterized by higher costs, due in particular to the respect of traditional methods (Fal Oyster, Sobrasada de Porc Negre). Actors involved maintaining these heritage productions accept lower return share, even if in some case it may question the resilience of those production systems.

Comparing Figure 4 and Figure 5, no trends appear, especially regarding processing. At this point, we can just conclude that there is no strong correlation between performance at upstream and processing level for PP and GOM.

**Figure 4. Price premium and GOM differential according sectors and FQS types at upstream level (n=22)**

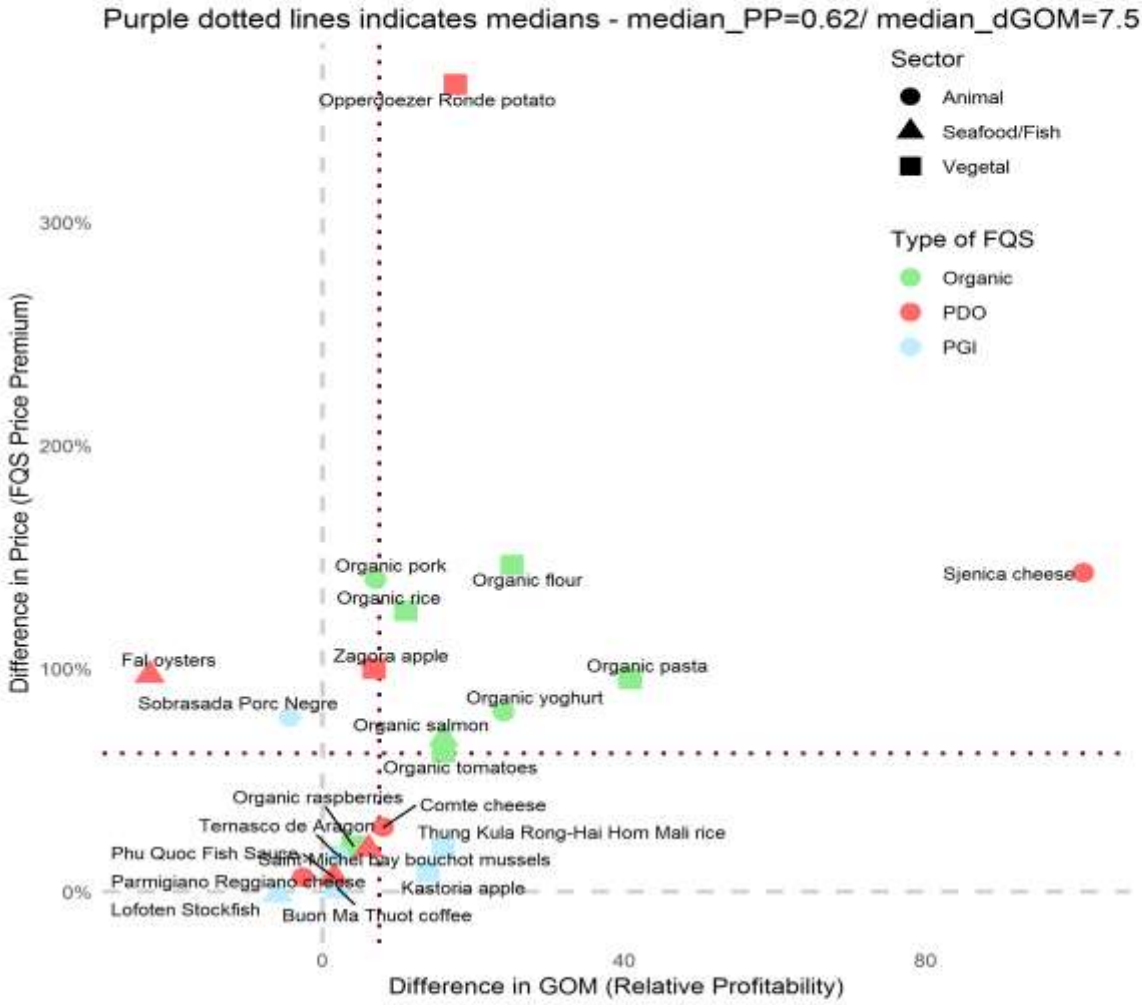
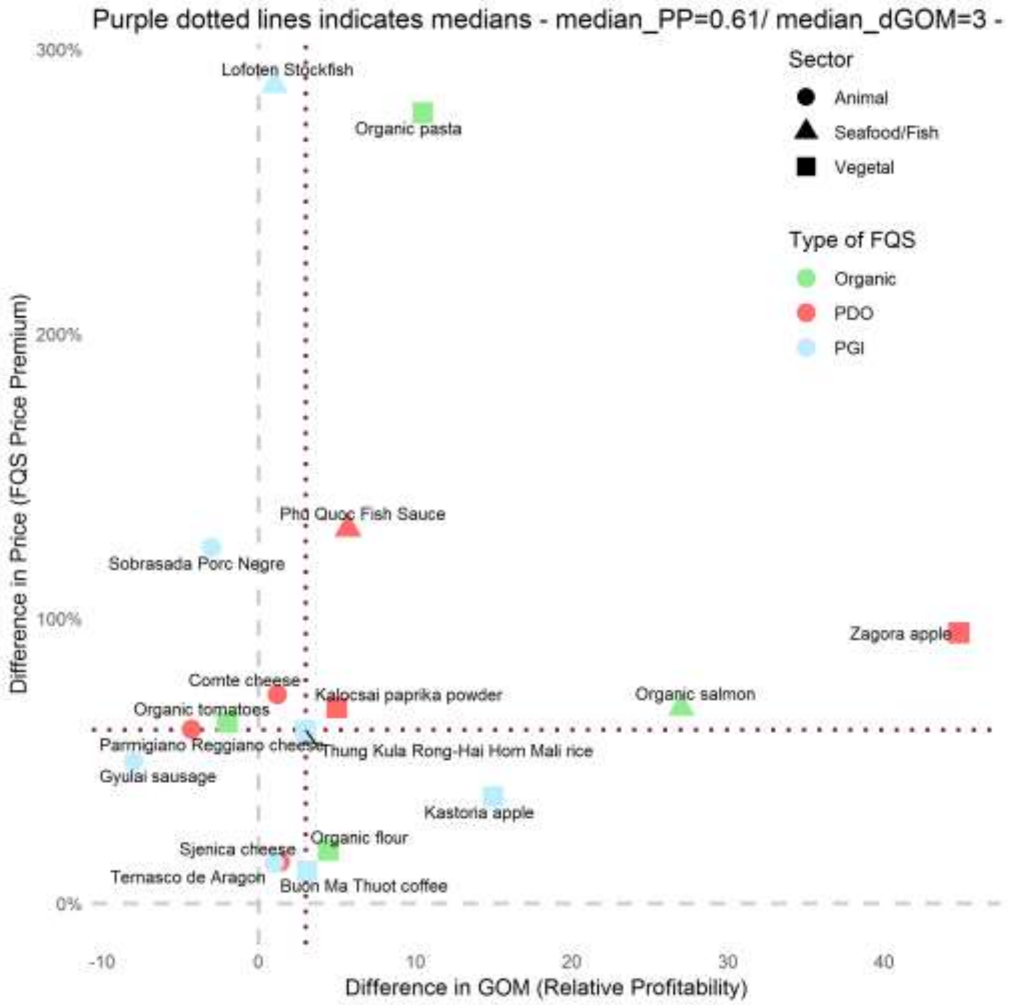


**Figure 5. Price premium and GOM differential according sectors and FQS types at processing level (n= 17)**



#### 2.1.1.6. FQS productions present various configurations regarding export share

To perform an accurate analysis of exports, we must take into account the volumes of production. Some FQS products have limited production or are not intended for export. This is the case for local product, without any specific recognition outside the country (and even sometimes outside the region). The appropriate sales network to value the product is direct selling (Olive oil from Croatia) or local and national markets. This is also the case for products for which local and national demand is higher than supply, like for some organic products (German organic pork or yoghurt; or French organic wheat flour for example).

At the other side, some FQS products have a strong and historical recognition across borders. This is the case for example for Parmigiano Reggiano, Lofoten Stockfish, Serbian organic raspberries, and Norwegian organic salmon; although the last two are as export-oriented as their reference product.

Considering those specificities makes it difficult to have a general and aggregated consideration on export as a performance indicator. However, we may consider that more that exports, the diversity of markets achieved by one product can reinforce its sustainability and its resilience. In that sense, exports could be an opportunity to diversify market for FQS products.

Duvaleix-Treguer et al. (2015) analysed the impact of the Protected Designation of Origin (PDO) label on the competitiveness of French companies exporting products from the cheese and cream industry. They showed that the role of the AOP label on the export performance is positive and seems more important when the export is to the countries of the European Union.

**Table 9. Average share of exported volume and value**

| | | **FQS** | **Reference** |
|---|---|---|---|
| *Value* | Europe | 13% | 20% |
| | Extra Europe | 10% | 16% |
| *Volume* | Europe | 15% | 20% |
| | Extra Europe | 8% | 14% |

The main result is that reference products have a higher volume export rate than FQS products (Table 8). To conduct this comparison we have to deal with the respective size of the markets and the recognition of products, which may depend on its historical trajectory.

### *2.1.2. Discussion*

#### 2.1.2.1. Synthesis of main results

PP is always positive and null in two cases. For some PGI, upstream level is not included in technical requirements, and thus no price premium is generated at this level. The positive price premium is consistent with results of numerous studies conducted at retail level which exhibit a consumer's willingness to pay for organic food (Dimitri and Dettman, 2012; Maigné et al. , 2017;Wier et al. 2008), PDO products (Fotopoulos and Krystallis, 2003; Garavaglia and

Mariani 2017; Panin et al., 2015) and PGI products (Ahrendsen and Majewski, 2017). However, we go beyond these previous results by having a sufficient number of cases to demonstrate a significant statistical difference between FQSs and their references, and between FQS types.

PP is highest for organic products than for PGI and PDO products. At upstream level profitability for organic product is, on the whole, the highest. Subsidies are partly responsible for this higher PP at farm level.

Another result from case studies is that relative distribution of value along the chain is not different comparing FQS and reference. In other words, the share of created value remains unchanged between levels comparing FQS and reference value chains.

The analysis of profitability (in terms of gross operating margin) highlights the dispersion of this indicator. Price premium and profitability are not perfectly correlated. Analysing economic sustainability of FQS requires taking into account the balance between price premium and additional costs due to meet specific requirements of FQS.

#### 2.1.2.1. Methodological issues and limits

We analysed profitability based on *Gross Operating Margin*, including main but not all costs. *Net result*, which includes other costs like depreciations, would give a more accurate view on profitability differential between FQS and reference. Indeed, FQS may generate specifics investments for buildings, equipment and other kinds of capital assets. However data on depreciation are difficult to obtain, considering time and resources available for case studies. It requires to access to detailed and rigorous accounting data. In the other hand, depreciation may be connected to other determinants than FQS and so difficult to analyse. GOM includes main direct costs, easier to collect and analyse in order to value economic performance of FQS.

Production units, both at upstream and processing levels, may be involved in several productions not only FQS. Data are not always available at FQS level but rather at unit level, including different productions. This may skew our results as we apply to FQS results from different production workshops (farm producing not just FQS vegetal or animal products, factory processing several kinds of cheese, etc.). As for all indicators, this was primarily addressed by considering firms as involved in the FQS value chain only if more than 50% of its turnover is based on the FQS (Bellassen et al., 2016). In addition, when possible, specific data from FQS workshop were extracted or estimated based on more or less accurate weighting coefficient. However cost accounting is not always available, and even less considering aggregation of economic units.

At the other hand, considering economic results separating FQS from other activities at unit or territory level does not always make sense. Previous studies have shown that complementarities may be important to consider the overall sustainability of a production system (Bontemps et al., 2013), whether at individual production unit level (economies of scope) or territory level (bundle of goods and services – "paniers de biens et services").

In terms of interpretation, a FQS less profitable than a reference product is not necessarily a no economically sustainable product. Some FQS, especially GI ones, aim at maintaining a traditional production linked to a specific cultural heritage. The option is not about more or less profitable product, but on Moreover the capacity of keeping alive a specific production system involving several natural and cultural amenities, and dealing with rural development issues is an issue to deal with.

Finally, a main issue is related to reference product. As stressed for other indicators, the choice of reference products significantly impacts the results as FQS sustainability is analysed based on a benchmarking approach FQS vs. Reference. The way of choosing and evaluating reference is not straightforward, as it depends on case specific assumptions and also on data availability (Bellassen et al., 2016). This should be taken into account while analysing each product.

## 2.2. Economic spillover of food quality schemes on their territory

### *2.2.1. Local multiplier*

The local multiplier indicator developed for this project can be interpreted as the cumulated flows of money within the local economy generated by 1 € received by the processing firms. It had to be adapted from other existing specifications of local multiplier so that is could be estimated for an entire value chain – as opposed to a single firm or entity – and despite the data availability constraints of most FQS.

### *2.2.2. Results for vegetal sector*

After the method of calculation, local multiplier can assume values ranging between 1 (null contribution to local economy) and 3 (all the suppliers in the value chains are local). Almost of vegetal products exceed a local multiplier value of 2 (Figure 6). This means that 1 euro spent within the value chain generates one more euro for the local economy. FQS exhibits a better contribution than the reference products, except for organic flour. Organic flour differs from the other products both in the absolute level of local multiplier and in comparison with its reference. This is due to the fact that local organic grain is not sufficient to satisfy the milling industry, so that a significant part of the raw material originates from outside the NUTS2 region of the mill.

The local contribution of reference products is not very different from the FQS. The average discrepancy between FQS and reference is slightly higher than 2%, although some more relevant inner differences exists, as in the case of Carmargue rice, Buon Ma Thuot Coffe and French Organic flour (Figure 7). The median local multiplier confirms the fact that FQS and reference have a similar impact at local level: for both the products the median is 2.3 (1 euro spend triggers a financial flow of 2.3 euro in the local economy). Indeed, despite the focus of many GIs on the local sourcing of the raw material, local sourcing largely happens for the reference product as well: transporting raw food products is costly due to their low density (Kilkenny, 1998) and processing plants accordingly source their raw materials from their neighbourhood to the extent possible (Bellassen et al., submitted).

**Figure 6. Local multiplier indicator for FQS and reference products – Vegetal sector**

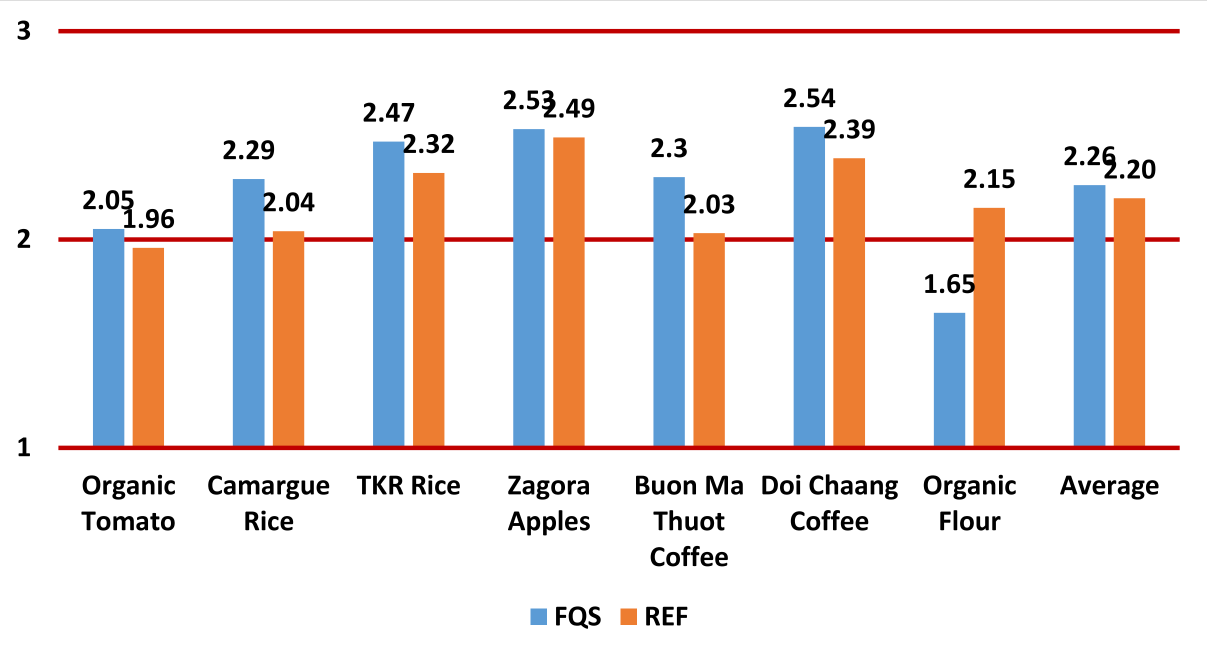
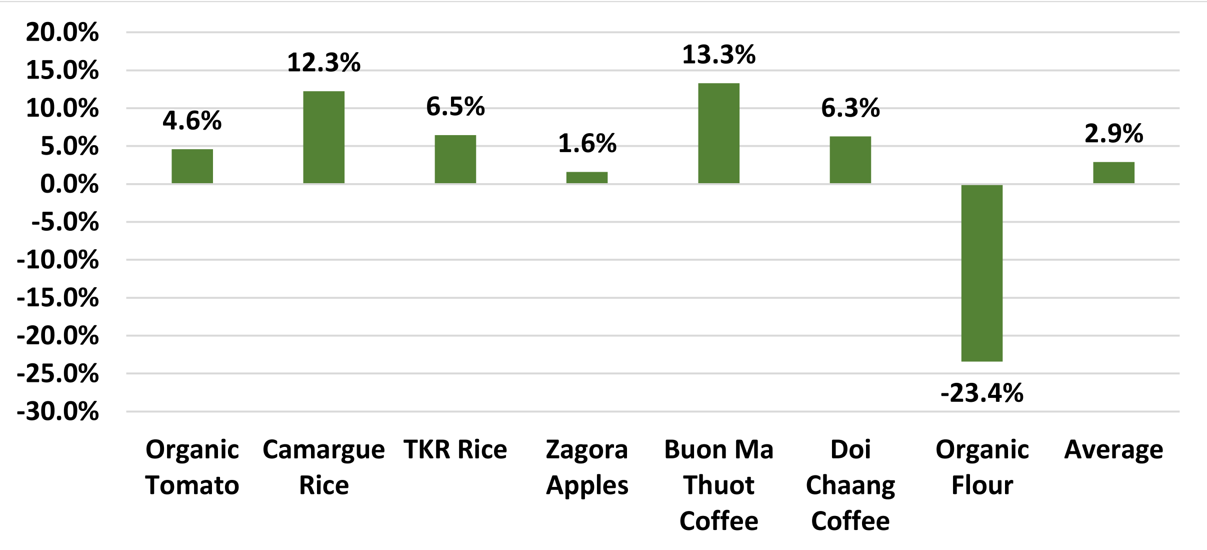
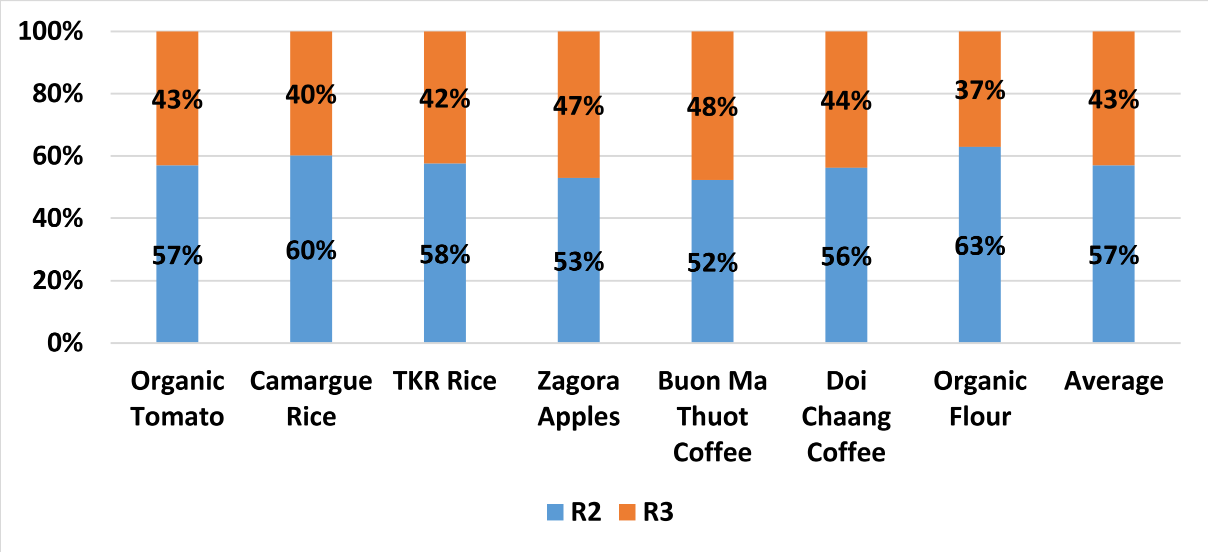



**Figure 7. FQS variations in local multiplier with respect to the reference – Vegetal sector**




The analysis of the local multiplier composition shows that the local financial flows along the supply chain rounds are substantially even distributed between first and second tiers suppliers. Figure 3 demonstrates this finding, where third round (second tier suppliers) loose part of the financial flow produced by the second round. This financial leakage effect is due mostly to the non-core inputs second suppliers, less committed in the supply chain than the core input suppliers; in any case, their contribution is not negligible, although slightly lower that the first tiers suppliers. It is also noteworthy that in the case of organic products the average local multiplier appears lower than for the other FQS products. Therefore, the strict connection between supply chain and territory boundaries in the case of PGI and PDO products, as defined by the relative codes of practices, affects positively the economic impact produced in the local area.

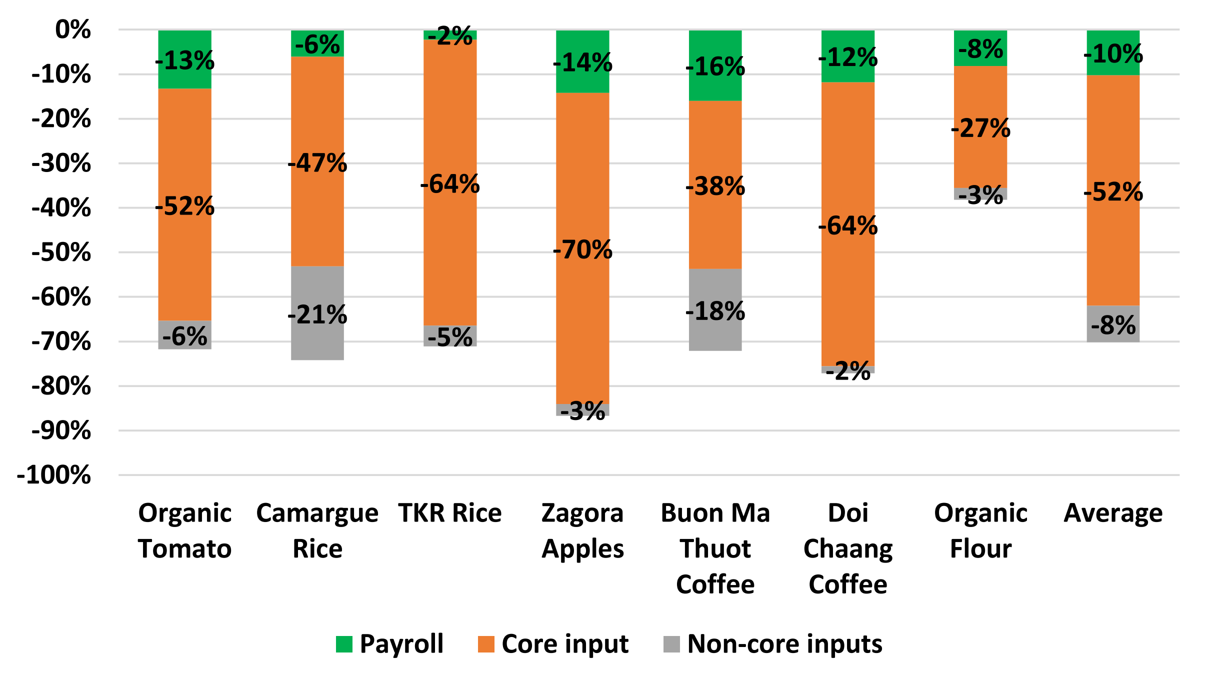
**Figure 3: Round composition – Vegetal sector**




For identifying the main determinants of local multiplier, we assumed the disappearance of local suppliers within the value chain for each FQS products. The negative contribution to the local economy impact has been measured for the three main costs sustained within the supply chain: payroll, core input costs and non-core input costs (Figure 8) shows According to the "no-local contribution" scenario, the core input expenditure appears as the most important element driving the local economy impact. This means that the geographical location of core input suppliers represents a key determinant for every FQS products. The second main determinant is payroll for three out of six products, and non-core input expenditure for the others.

**Figure 8. Local multiplier determinants – Vegetal sector**

Each colour in each bar simulates the change in local multiplier when the associated category (payroll, core input, non-core inputs) is entirely non-local. When all three categories are non-local, the local multiplier is equal to 1, i.e. no local economy impact.




### *2.2.3. Results for animal sector*

We considered for the local multiplier calculation eight animal products. For sake of simplicity, fish and seafood products are included in this category.

For four out of eight products, the local multiplier for FQS products reaches very high values, in some cases very close to 3 (Figure 9). We remind that a local multiplier value of 3 means that all the financial flows are retained within the local area. Ternasco d'Aragon, for instance, exhibits a local multiplier of 2.97, i.e. almost every (first and second tier) suppliers are local. Unlike vegetal products, animal sector shows a sort of dichotomy in local multiplier values: most of FQS products are characterized by very high index value, while the other cases present very low values or below 2. This index heterogeneity within this group of products exacerbates in the case of Gyulai sausage, where raw material originates far away from the place where the meat is processed, and for Ternasco d'Argaon, where all the inputs are local. This is an effect of the code practice rules, which allow in the case of Gyulai sausage outside the region where the meat is processed, while for Ternasco d'Aragon lamb meat originates within the local area.

The average value of local multiplier for FQS products and their references is above 2, with a higher value for FQS than its reference for all the products except for Organic Salmon. The average difference between FQS and their reference is 18%, while the median difference is 24%. This is a consequence of the higher local multiplier variability for the animal productions than for vegetal ones. The product exhibiting the highest difference with respect to their references are Sobrasada de Mallorca, with a local multiplier more than double of its reference, and Sjenica cheese, with a local multiplier for FQS 52% higher than the reference product

(Figure 10). For this PGI product the budget share associated with the core and other intermediate inputs remaining within the local area, both for first and second tier suppliers, is much lower in the case of non-PGI cheese. Because of information confidentiality issues, it was not possible to calculate the local multiplier for the reference product of Dalmatian Prosciutto, but it is likely much higher than the FQS as pork is locally sourced whereas it is imported from Hungary and Austria in the FQS. Overall, animal products seem to perform better than the vegetal products, which is again consistent with transport costs, likely higher for animals than for vegetal products.

**Figure 9. Local multiplier indicator for FQS and reference products – Animal sector**

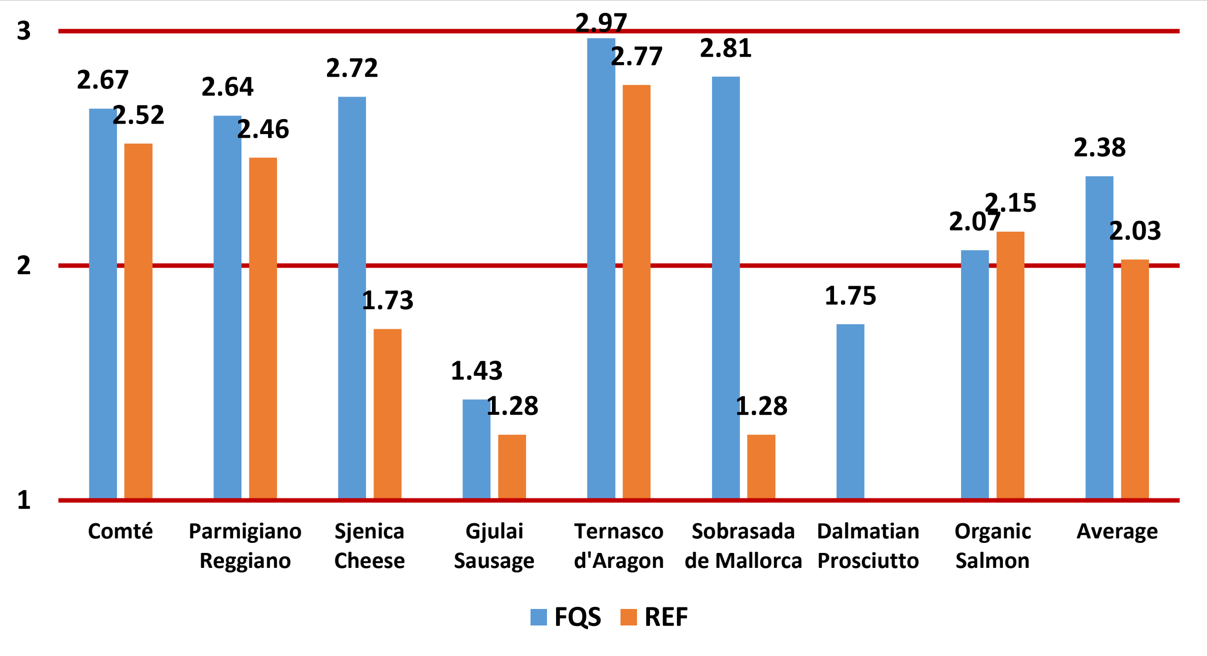
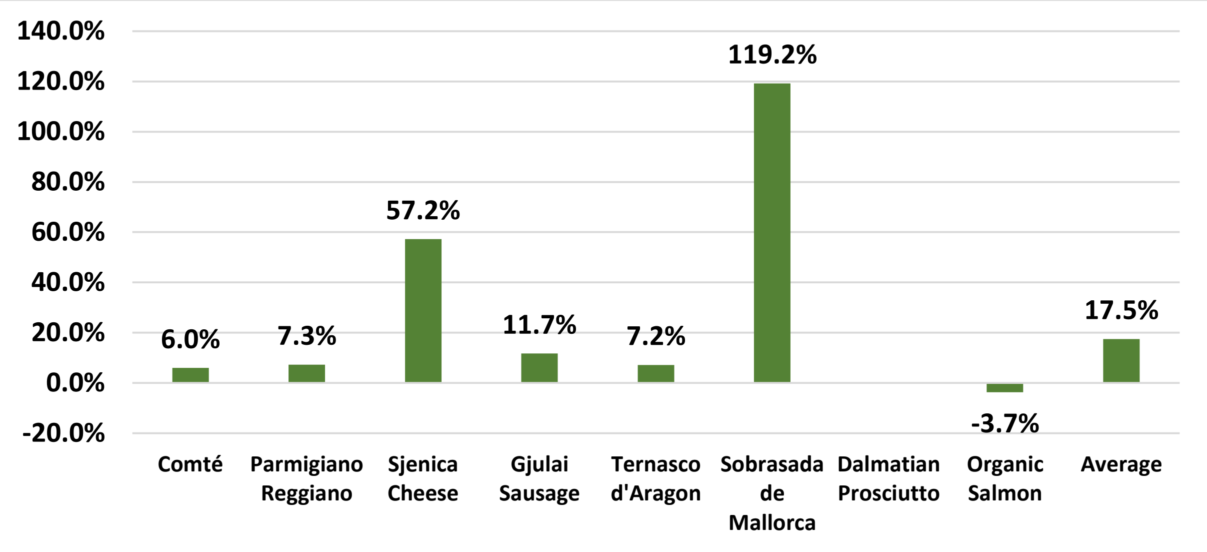
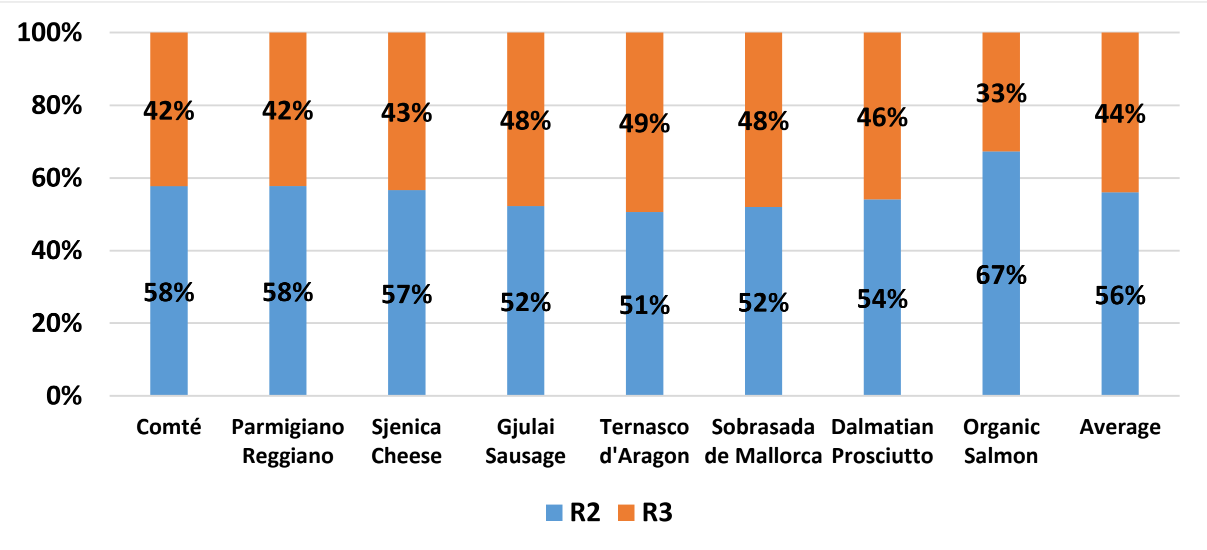


**Figure 10. FQS variations in local multiplier with respect to the reference – Animal sector**



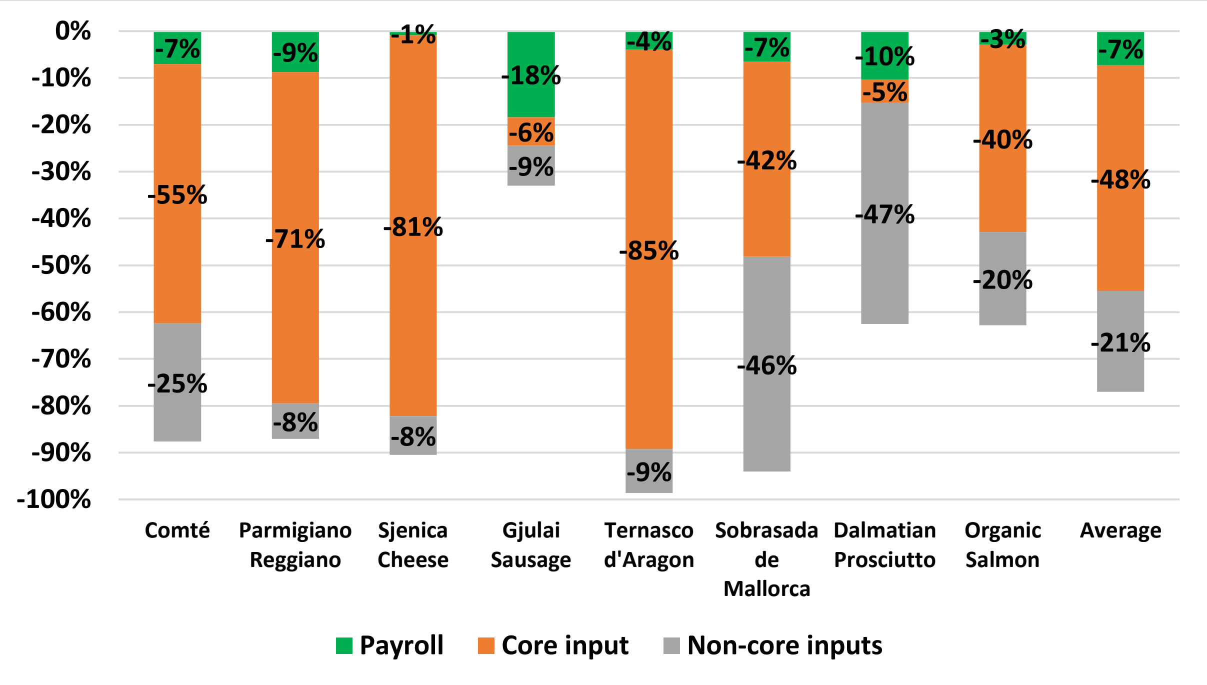

As for vegetal productions, the round composition of animal sector is evenly distributed between round 2 (suppliers to the processing plants) and round 3 (suppliers to the farms, Figure 11). Also in this case, round 2 retained most part of the local economy impact, while in round 3 part of the financial flows originating from the second round is leaked. In average, second round contributes to the local financial flows for 55% of the entire extra-value generated at local level by the initial budget, while the third round accounts for the remaining 45%.

**Figure 11. Round composition – Animal sector**




The main determinant of the local multiplier indicator is not unique across products (Figure 12). For four out of six products, the main drivers for the positive local economy impact is the core input expenditure. Therefore, the location of raw material suppliers, i.e. farmers, plays the most important role in defining the contribution to the local economy. In the case of Sjenica cheese and Ternasco d'Aragon, the core input contribution is above 80%. On the contrary, for Gyulai sausage and Dalmatian Prosciutto the core input expenditure represents the minor determinant in local multiplier. As mentioned above, the meat suppliers for Gyulai sausage and Dalmatian Prosciutto are non-local. It is noteworthy that for Gyulai sausage the main driver is the staff payroll, while for Dalmatian Prosciutto is the non-core input expenditure. This difference could be due to the production technology and the share of local non-core input costs: more labour intensive for Gyulai sausage process and more local non-core input suppliers for Dalmatian Prosciutto.

**Figure 12. Local multiplier determinants – Animal sector**




### *2.2.4. Sector comparison*

The average and median local multiplier for animal sector is higher than for vegetal sector (Figure **13**). The average difference is 5% and median difference is 15%. The higher local multiplier for animal sector is characterised also by a higher variability: the standard deviation for animal sector 1.55, while for vegetal sector 0.62. Therefore, the local multiplier for animal FQS is more heterogeneous than for the vegetal one.

In terms of local multiplier composition, it is not possible to identify different patterns. In both cases, round 2 and 3 presents similar shares. Also for the local multiplier determinants, local raw material drives the economic impact within local area. The second most important determinant is the payroll for the vegetal sector and non-core input expenditure for animal productions (Figure 14).

**Figure 13. Average local multiplier by sector**

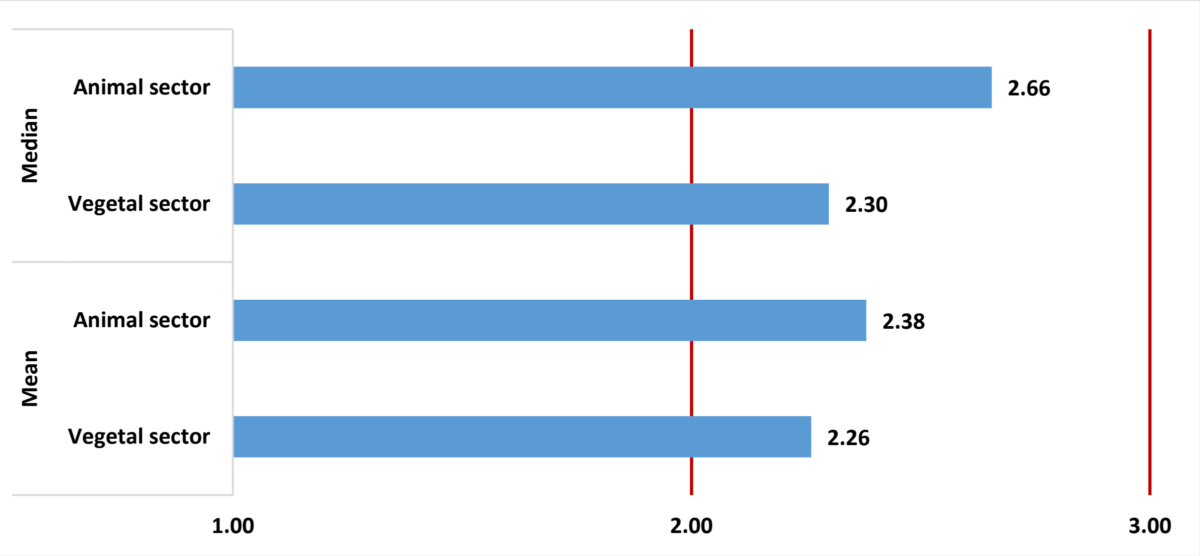
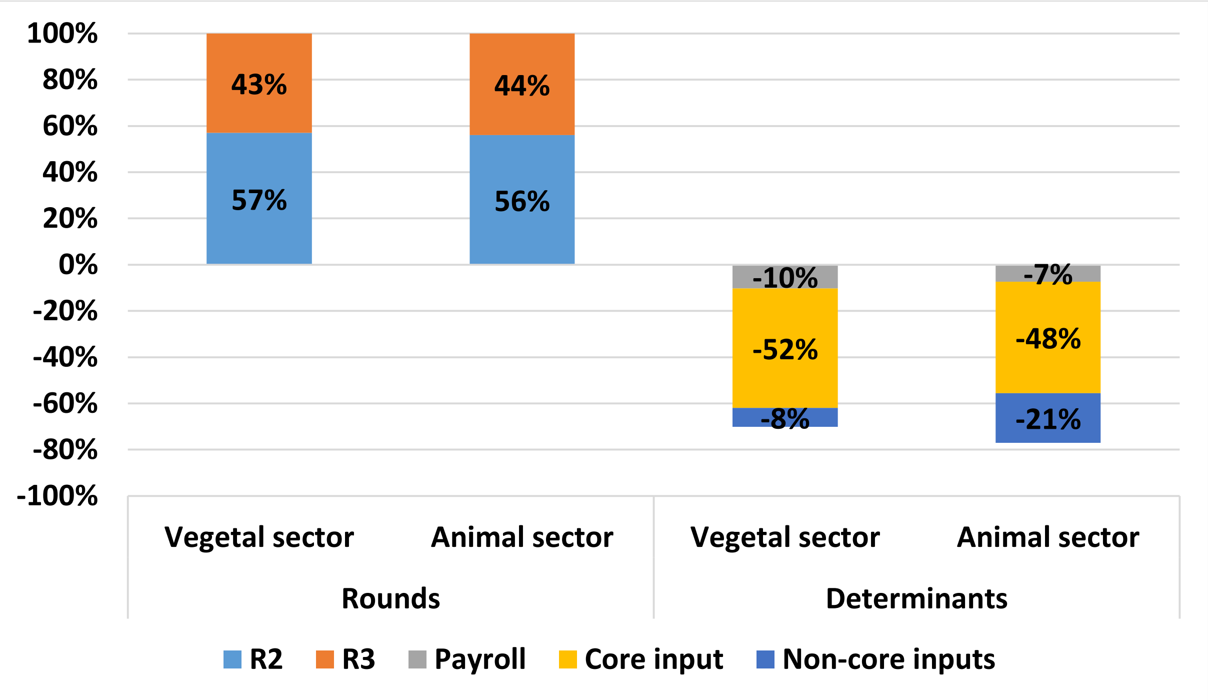



**Figure 14. Average contribution to local multiplier by sector**



# 3. Environmental impact of FQS and its determinants

## 3.1. Carbon and land footprint of quality food

### *3.1.1. Results*

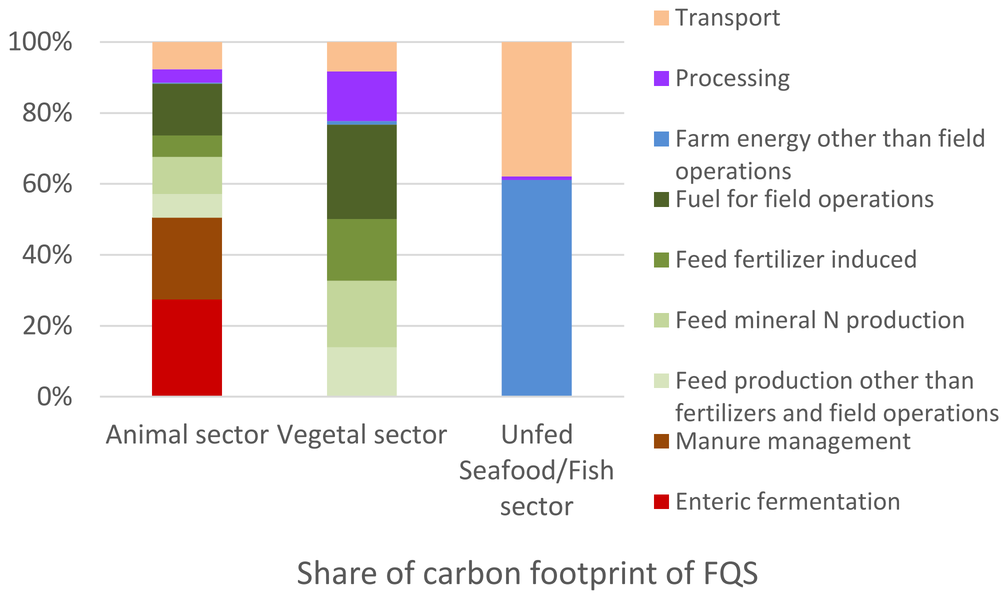
#### 3.1.1.1. Most emissions occur before the farm gate

For animal products, 89% of the carbon footprint is emitted before the animal or its products leave the farm (Figure 15). This figure drops to 79% for vegetal products and to 61% for unfed seafood and fish. This dominance of farm processes and fertilizer production is consistent with the literature (Röös et al., 2014; Weber and Matthews, 2008). Fertilizer-use is responsible for around 40% of emissions from crop production and fuel use for field operations is responsible for another third. The rest comes from crop residues, background emissions and, in the case of flooded rice, anaerobic methanogenesis.

Because transport represents only a small fraction of the carbon footprint for most FQS products and because the system boundaries on which it has been assessed is not strictly identical across cases, it is not considered in the rest of the analysis.

**Figure 15. Average composition of the carbon footprint of FQS products**

Feed stands for either feed (animal products) or crop (vegetal products).




#### 3.1.1.2. Lower carbon footprint per hectare, variable performance per ton

The carbon footprint of Food quality schemes is clearly lower than their reference on an area basis: the median difference is 29% lower, with three fourth of the cases substantially improving upon their reference and 91% not substantially worse (their difference in performance is at most -10%, see Table 9). The picture is less clear when carbon footprint is expressed per ton of output: the median difference is close to zero and only 42% of the cases substantially improve upon their reference. The comparison is however more favourable to FQSs when it is performed at the level of original products (e.g. milk for cheese, wheat for flour): more than two third of FQSs are not substantially worse than their reference at farm level. The land footprint of FQS is clearly higher than their reference: the median difference is 35% higher, with three fourth of the FQSs having a substantially higher land footprint.

**Table 10. Carbon footprint of Food quality schemes**

| Type of carbon footprint (CF) | Cases with indicator | Median difference | Min / Max difference | Share of cases with difference < -10% | Share of cases with difference < 10% |
|---|---|---|---|---|---|
| CF of final product (kgCO2e ton-1 final product) | 26 | -4% | [-51% - 142%] | 42% | 62% |
| CF of original product (kgCO2e ton-1 original product) | 26 | -12% | [-67% - 166%] | 50% | 69% |
| CF of area (kgCO2e ha-1) | 23 | -29% | [-71% - 26%] | 83% | 91% |
| Land footprint (ha t-1) | 23 | 35% | [-56% - 697%] | 17% | 26% |

#### 3.1.1.3. No clear-cut difference per FQS or sector, except for organic vegetal products

There is no clear-cut difference in carbon footprint per ton of final products between the different categories with the only exception of products which are at the same time vegetal and organic (Table 10). Indeed, all these products have a substantially lower carbon footprint than their reference. While the median difference for all vegetal products is the same (-14%), one fourth of the category, all GIs, has a substantially higher carbon footprint than its reference.

**Table 11. Difference in carbon footprint per ton of final product for different categories**

| Subcategory | Cases with indicator | Median difference | Min / Max difference | Share of cases with difference < -10% | Share of cases with difference < 10% |
|---|---|---|---|---|---|
| Animal sector | 10 | 15% | [-15% - 142%] | 20% | 30% |
| Vegetal sector | 13 | -14% | [-51% - 84%] | 62% | 77% |
| Unfed Seafood/Fish sector | 3 | -6% | [-48% - 1%] | 33% | 100% |
| Geographical indications | 18 | 4% | [-51% - 142%] | 39% | 56% |
| of which PDO | 10 | 4% | [-45% - 84%] | 30% | 60% |
| Organic | 8 | -9% | [-43% - 23%] | 50% | 75% |
| Vegetal x GI | 8 | -29% | [-51% - 84%] | 63% | 63% |
| Vegetal x PDO | 4 | -7% | [-45% - 84%] | 50% | 50% |
| Vegetal x Organic | 5 | -14% | [-43% - -3%] | 60% | 100% |

### *3.1.2. Discussion*

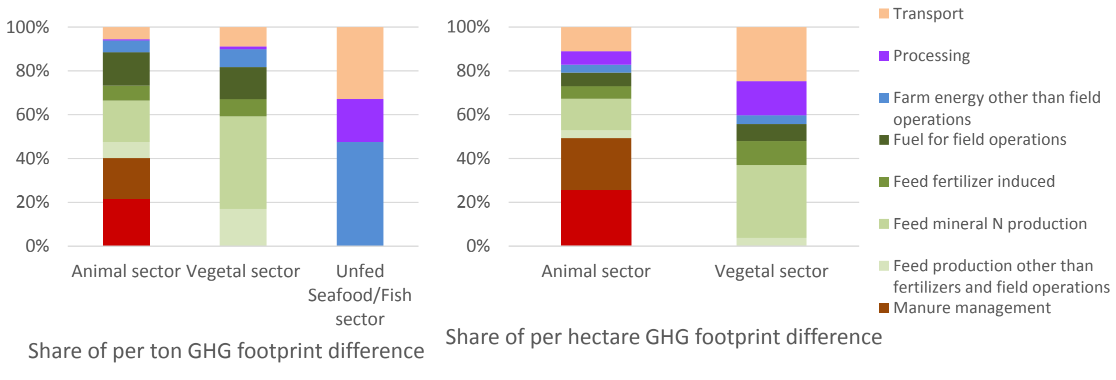
#### 3.1.2.1. Technical specifications often impact three key drivers of the carbon footprint: fertilizer use, product concentration and animal efficiency

In vegetal sectors, the bulk of the differences in carbon footprint is driven by fertilizer production and use (Table 11). In many cases, the technical specifications play a role in driving it down: mineral fertilizers are forbidden in organic production, although they are partly substituted with organic ones, and the specifications related to feed composition are often oriented towards less fertilized feed (e.g. ban on maize silage promoting alfalfa for Parmigiano, promotion of grass and limitation of concentrates for Comté and organic yoghurt, …). In several cases, the lower and more efficient use of fertilizers does not directly stem from the technical specifications but is indirectly related to the FQS via the access to technical advice by cooperatives involved in the FQS (e.g. Kastoria and Zagora apples, TKR Hom Mali rice). Note that in many cases however, the FQS influences neither directly nor indirectly the use of fertilizers. That is, among others, the case of PGIs. The only case where fertilizer use is higher than the reference is Doi Chaang coffee. Overall, the theoretical incentive given by higher FQS prices to increase productivity on the intensive margin is not materialized by an increase in fertilizer use.

In animal cases, two other important drivers come to play. The first is simply product concentration: given that is requires twice as much milk to make one ton of Parmigiano cheese than to make one ton of its reference, the carbon footprint of Parmigiano is almost twice higher. Although three other products also require substantially more raw material per ton of final product than their reference – Dalmatian Prosciutto, Gyulai sausage and organic pasta – this is not a general trend. Several FQS products such as Croatian olive oil or Comté cheese even require less raw material than their reference thanks to a higher processing efficiency or a higher quality of the raw material.

The second pertains to how efficiently the animal herd transform feed into food. The more feed is required, the more GHG are emitted from enteric fermentation, manure management, and, of course, feed production. On these aspects, FQS tend to perform worse than their reference although for a variety of reasons, often related to technical specifications. Sobrasada pigs for example live twice longer and exercise much more than their reference, thus "wasting" much more feed in maintenance and exercise. Similar although less pronounced differences drive a lower feed to food conversion efficiency in organic yoghurt, Comté cheese and organic pork. In the latter, the lower number of piglets per sow also increases the relative "deadweight" of sows on the carbon footprint of fattened pig meat. In the singular case of Sjenica cheese, where a cow cheese was chosen as the reference for a sheep cheese, most of the higher footprint of the FQS is driven by the much lower conversion feed to milk conversion efficiency of ewes.

**Table 12. Average contribution of each emission source to the difference in carbon footprint**

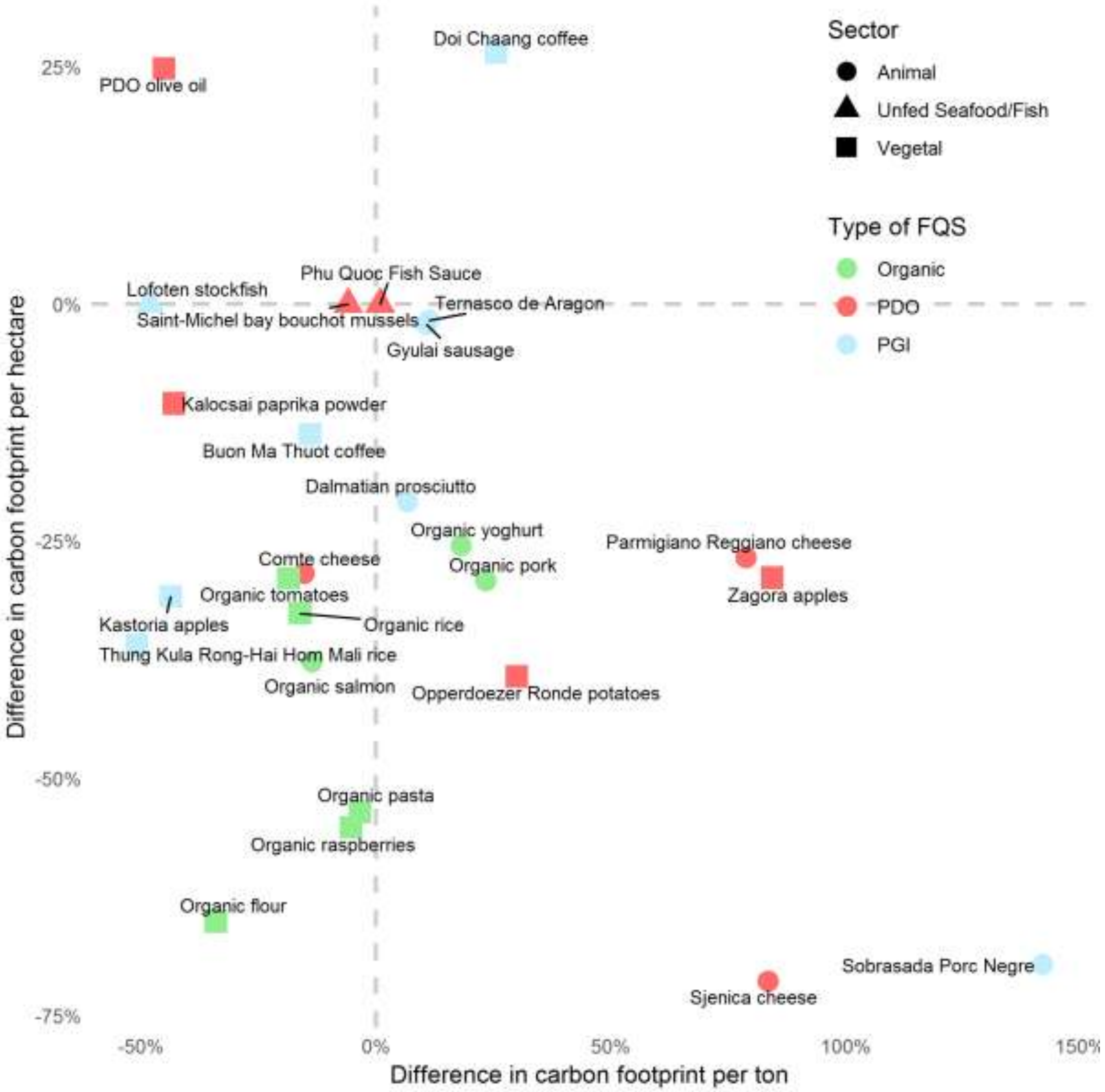



#### 3.1.2.2. Yield and terroir

Another important factor driving the differences in per ton carbon footprint and in land footprint is yield. This translates into a negative correlation between per ton and per area carbon footprints, especially if organic products are excluded (Figure 16). The pedo-climatic conditions or *terroir* as they are referred to in the GI literature[2] often drive this difference, but it can go either way. In some cases such as Croatian olive oil, Kastoria apple or Kalocsai paprika powder, the pedo-climatic conditions allow for higher yield in the FQS. To the contrary, the pedo-climatic specificities of Zagora apple and Doi Chaang coffee constrain their yield.

Naturally, this *terroir* effect interacts with crop practices: irrigation and higher technicity certainly help Kalocsai paprika farmers in achieving higher yields while the shorter growing season mandated by the Opperdoezer potato technical specifications necessarily reduces crop yield.

**Figure 16. Carbon footprint per hectare and per ton**




[2] Rigorously speaking, *terroir* is a combination of pedo-climatic conditions and traditional know-how.

#### 3.1.2.3. Unfed seafood and fish

The unfed seafood and fish sector has a peculiar carbon footprint pattern because the two usually dominant emission sources – namely enteric fermentation and fertilizer use – do not occur in this sector. As a result, their carbon footprint – largely driven by diesel use for boat operation – is modest compared to other animal products. Differences in carbon footprint between FQS and their reference are negligible for mussels and fish sauce, but more substantial for stockfish. Most of the advantage of Lofoten stockfish pertains to lower fuel needs to capture the fish because the technical specifications request that they fish “around Lofoten and Vesteralen”. To a lesser extent, energy savings at processing level – such as sun drying and the absence of freezing for Lofoten stockfish – also contribute to improve the carbon footprint of Lofoten stockfish.

#### 3.1.2.4. Methodological issues & limits

##### 3.1.2.4.1. Sensitivity analysis

The calculator used in this study – the Cool Farm Tool (Hillier et al., 2011) – makes two key assumptions that would be worth exploring through a sensitivity analysis. Firstly, unlike the IPCC (IPCC, 2006) and most life cycle assessments but similarly to more recent works (Carlson et al., 2016), the calculator uses a non-linear relationship between $N_2O$ emissions and fertilizer use derived from Bouwman et al (2002). As a result, even fields where no fertilizer is applied emit some $N_2O$ and the marginal impact of one kilogram of nitrogen increases with the total amount applied. Carlson et al. (2016) shows that this type of relationship can decrease carbon footprint estimates by 30% which is consistent with our estimates being generally in the lower end of the literature range.

Secondly, the emissions stemming from the application of organic fertilizers such as manure and compost are attributed to the crop they fertilize rather than to the production – generally livestock – which generated them. While this approach is the most frequently used in the life assessment literature and is retained by the IPCC for inventories (IPCC, 2006), it is questionable: manure is often waste produced in excess by livestock farms and breeders are usually happy to get rid of it for free. Therefore, attributing all its emissions to the production which generated them may be warranted, and this change likely has a substantial impact on the results, likely benefiting organic products at least.

##### 3.1.2.4.2. System boundaries and unaccounted factors

While the system boundaries retained for this study – from cradle to processing plant gate – is already wider than many existing studies, we may have enough data to expand it to transport-related emissions. However, this would require careful consideration of the comparability of the segments for which transport can be estimated across case studies.

Other factors such as crop residue management, soil and climate conditions and juvenile death rate have been neglected in this analysis and could be included in future refinements.

##### 3.1.2.4.3. Data sources

While the data collection procedure follows some generic guidelines and includes a thorough quality checks, the specifics were allowed to vary from one case to the other in order to fit with the national circumstances. Some cases – e.g. organic pork, organic yoghurt, Comté cheese– were able to rely on secondary data bolstered by a large sample size while other cases had to collect primary data on a small – usually five to ten – sample of farms (e.g. Kastoria and Zagora apple, organic raspberries, …). This heterogeneity clearly generates some noise but the only way to remove it would be to identify firms involved in other FQS than organic in large statistical surveys such as the Farm Accountancy Data Network and the Statistical Business Survey. Furthermore, some adjustment to these surveys would be necessary to cover the key drivers of carbon footprint: as demonstrated by the FP7 FLINT project (Vrolijk et al., 2016), deriving environmental indicators from the current FADN is not straightforward.

Similarly, some common generic guidelines were followed to select the reference product, but again, the specifics were allowed to vary from one case to the other in order to fit with the national circumstances (Table 12). It may be worth exploring the sensitivity of results to a systematic use of national averages derived from large databases such as FADN, AROPAj and Mueller et al. (2012). Indeed, this would provide a more homogeneous reference but often at the expense of regional matching and updated data.

**Table 13. Data sources and reference product**

| Case studied | Country | Reference product | Most important data sources |
|---|---|---|---|
| Dalmatian ham | Croatia | Local non-PGI firm | FQS: FADN, Jayet (2017), Mueller et al. (2012)<br>Reference: Interviews, Mueller et al. (2012) |
| PDO olive oil | Croatia | National average | FQS: interviews<br>Reference: Mesic et al. (2014) |
| Comte cheese | France | National average (cow cheese) | FQS: IDELE France-Comté (2016), Agreste (2011), ADEME (2017), interviews<br>Reference : IDELE (2012), Agreste (2011), ADEME (2017) |
| Organic flour | France | National average | CA Rhône-Alpes (2012), CA Occitanie et CER Occitanie (2016), Agreste (2011), Passion Céréales (2017), Juin (2015), Espinoza-Orias et al. (2011), interviews |
| Saint-Michel bay bouchot mussels | France | National average (TSG Bouchot mussels) | Interviews and accountancy data from farms (averaged over 2011-2014) and one processor (2017) |
| Camargue rice | France | Non-organic rice (mostly PGI) | Delmotte (2011), Ari Tchougoune (2018), Barbier (2018), Monier (2018), interviews |
| Organic pork | Germany | National average | Kool et al. (2009), Gorn (2017), Destatis (2017), Ecoinvent, Knudsen et al. (2010), interviews |
| Organic yoghurt | Germany | National average | Kool et al. (2009), Knudsen et al. (2010), KTBL (2017), BOLW (2016), Thünen (2017), Hülsbergen & Rahmann (eds.) (2013), Warnecke et al. (2014), interviews |
| Zagora apple | Greece | Kissavos apples (non-GI apples from another region) | Interviews and accountancy data from farms and cooperatives |
| Kastoria apple | Greece | Kissavos apples (non-GI apples from another region) | Interviews and accountancy data from farms and cooperatives |
| Gyulai sausage | Hungary | Non-PGI Hungarian sausage | FADN, Jayet (2017), Mueller et al. (2012), World Bank (2017), Kool et al. (2009), interviews |
| Kalocsai paprika powder | Hungary | Imported paprika milled in Hungary | FQS: interviews<br>Reference: Wang et al. (2018) |
| Parmigiano Reggiano cheese | Italy | Biraghi cheese (similar non-PDO cheese) | FQS and reference: Italian FADN (2014), Ribaudo (2011), ARAL (2017). |
| Organic tomato from Emilia Romagna | Italy | Conventional processed tomatoes in the same region (Emilia-Romagna) | FQS and reference: STUARD (2017), interviews, accountancy data from Consorzio Casalasco del Pomodoro |
| Opperdoezer Ronde potato | Netherlands | Regular potato in neighbouring IJsselmeerpolders region | FQS: Interviews, MsC thesis<br>Ref: KWIN-AGV 2015 report |
| Lofoten stockfish | Norway | Clipfish (cod) | NDF (2018), Winther et al. (2009), interviews |
| Organic farmed salmon | Norway | Conventional salmon | Cargill Aqua Nutrition (2017), Ytrestoyl et al. (2015), Williams et al. (2006), Knudsen et al. (2010), Oraqua (2013), NDF (2018), Winther et al. (2009), FAO (2018), interviews |
| Organic pasta | Poland | Simulated conventional farms with sample characteristics | Interviews and accountancy data from farms and processing plants |
| Sjenica cheese | Serbia | National average (cow cheese) | FQS: Grubić (2012), Serbian FADN, Poljosfera (2017), SORS (2015), interviews |

| | | | |
|---|---|---|---|
| | | | Ref: Interviews, Serbian FADN, West et al. (2014), Lesschen et al. (2011) |
| Organic raspberries | Serbia | National average | SORS (2015), RD&T (2012), Serbian FADN (2015) |
| Sobrasada of Mallorca | Spain | National average | Interviews and accountancy data, Jaume (2017), Monfreda et al. (2008), Mueller et al. (2012), West et al. (2014) , Lesschen et al. (2011), Jayet (2017), FADN |
| Ternasco de Aragon | Spain | Non-PGI lamb in the same region (Aragon) | Rodriguez et al. (2007), Monfreda et al. (2008), Mueller et al. (2012), West et al. (2014), Lesschen et al. (2011), interviews, Opio et al. (2013) |
| Thung Kula Rong-Hai (TKR) Hom Mali rice | Thailand | Non certified rice from the same region (90% of GI rice is organic as well) | Interviews of farmers, millers and other stakeholders, Toshiyuki et al. (2013), Srisompun et al. (2017) |
| Doi Chaang coffee | Thailand | | Interviews of farmers, millers and other stakeholders, Giovanucci et al. (2004) |
| Phu Quoc Fish Sauce | Vietnam | Non-PDO fish sauce from same region | Interviews and firm accountancy data |
| Buon Ma Thuot coffee | Vietnam | Non-PGI coffee from Dak Lak province in Vietnam | Interviews, Giovanucci et al. (2004) |

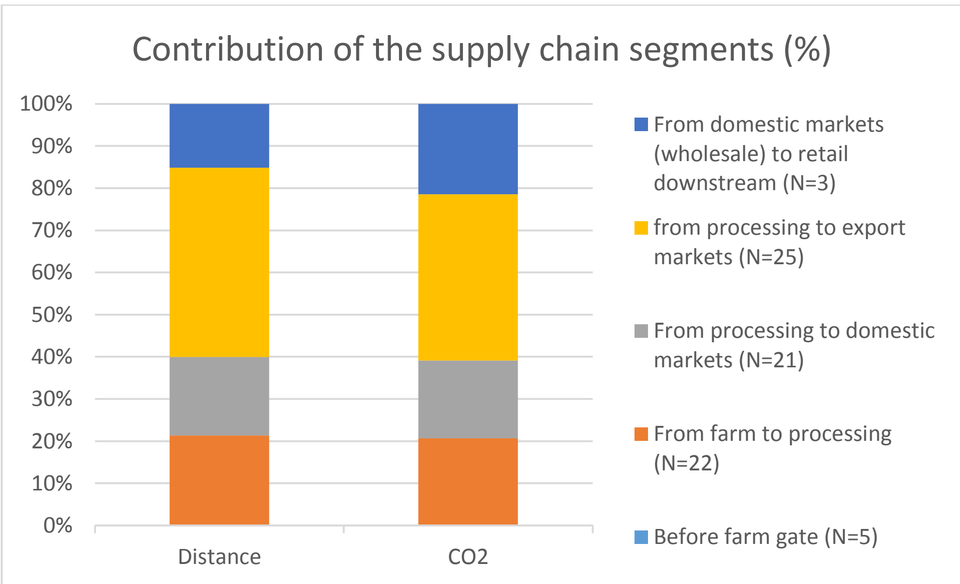
## 3.2. Food miles: the logistics of food chains

### *3.2.1. Results*

#### 3.2.1.1. Most distances and emissions occur after the processing plant

Figure 17 represents the contribution of each supply chain level to the total distances embedded in products and to the $CO_2$ emissions from the transport stage, for FQS products. 80% of the distances travelled and of the emissions from the transport stage occur after the processing plant, and more precisely for exports at retail level. This is true for all types of FQS (PDO, PGI, organic) and for all sectors (vegetal, animal and sea food). This pattern is however less pronounced for animal cases and PGI cases, for which a large share of miles and emissions occur at the processing level, between farms and processing units. This is because some animal cases rely heavily on imports of raw products (namely Dalmatian prosciutto and Gyulai sausage, which are also PGIs).

**Figure 17. Contribution of the supply chain segments to the distance embedded and to the $CO_2$ emissions from the transport stage (in %)**




NB: N indicates the sample size on which the average contribution is built

A methodological limit is that this contribution is calculated on a different number of case studies, according to the segment considered. Average contributions per segment are therefore built on different sample sizes (N). One has to be particularly careful as far as the downstream retail and farm levels are concerned, since results are built on data from 3 to 5 cases only, and do not cover all sectors nor all types of FQS.

#### 3.2.1.2. Shorter distances travelled for FQS

The distance travelled by FQS products along the value chain is clearly shorter than the distance travelled by their reference: the median difference is 26% shorter, with three fourth of the cases substantially improving upon their reference and 92% not substantially worse (Table 14). This difference is larger for vegetal cases and for PDO cases, with a median difference of about 60% in favour of FQS. The difference is smaller for animal and sea food cases, or for PGI and organic cases, although the median difference is always negative, indicating that at least half of the cases travel distances shorter than their reference. We also remark that all vegetal and sea food cases perform better than their reference in terms of distance travelled. Only some animal cases perform worse. Similarly, all organic cases also perform better.

Some products travel distances 100% shorter than their reference. This happens when only data for exports are available (therefore assuming no distance travelled upstream) and when only the reference case is exported.

**Table 14. Difference in distances travelled for different categories**

| | Cases with indicator | Median difference | Min / Max difference | Share of cases with difference < -10% | Share of cases with difference < 10% |
|---|---|---|---|---|---|
| FQS | 25 | -26% | [-100%; +270%] | 72% | 92% |
| Vegetal | 12 | -61% | [-100%; -2%] | 92% | 100% |
| Animal | 9 | -12% | [-100%; +270%] | 56% | 78% |
| Sea food | 4 | -11% | [-28%; -2%] | 50% | 100% |
| PDO | 9 | -60% | [-100%; +35%] | 78% | 89% |
| PGI | 9 | -20% | [-97%; +270%] | 56% | 89% |
| organic | 7 | -24% | [-100%; -2%] | 86% | 88% |

#### 3.2.1.3. Lower emissions from the transport stage for FQS

In line with results for distances, FQS products generate less emissions at the transport stage than their reference. Along the value chain, the median difference shows that emissions are 20% lower, with 56% of the cases substantially improving upon their reference and 80% not substantially worse (Table 14). The difference is larger for vegetal cases and for PDO cases, with a median difference of about 30 to 40% in favour of FQS, though less marked than the difference in distances. The median difference for sea food cases is positive (+10%) and no case substantially improves upon their reference. Even more so, 50% of the cases perform substantially worse than their reference. Interestingly, some vegetal and sea food cases, as well as some organic cases, release more emissions than their reference, although they travel shorter distances.

**Table 15. Difference in emission from the transport stage for different categories**

| | Cases with indicator | Median difference | Min / Max difference | Share of cases with difference < -10% | Share of cases with difference < 10% |
|---|---|---|---|---|---|
| FQS | 25 | -20% | [-100%; +270%] | 56% | 80% |
| Vegetal | 12 | -31% | [-100%; +45%] | 75% | 92% |
| Animal | 9 | -15% | [-100%; +270%] | 56% | 78% |
| Sea food | 4 | +10% | [-9%; +37%] | 0% | 50% |
| PDO | 9 | -38% | [-100%; +91%] | 67% | 78% |
| PGI | 9 | -9% | [-63%; +270%] | 44% | 78% |
| organic | 7 | -20% | [-100%; +45%] | 50% | 86% |

#### 3.2.1.4. FQS products travel shorter distances but generate proportionally more emissions

The environmental benefits gained by FQS products traveling shorter distances are partly offset by higher carbon content per kilometer travelled (Figure 18). On the contrary, reference products release proportionally less emissions compared to the distance they travel. Such a result indicates that transport of FQS is less carbon efficient.

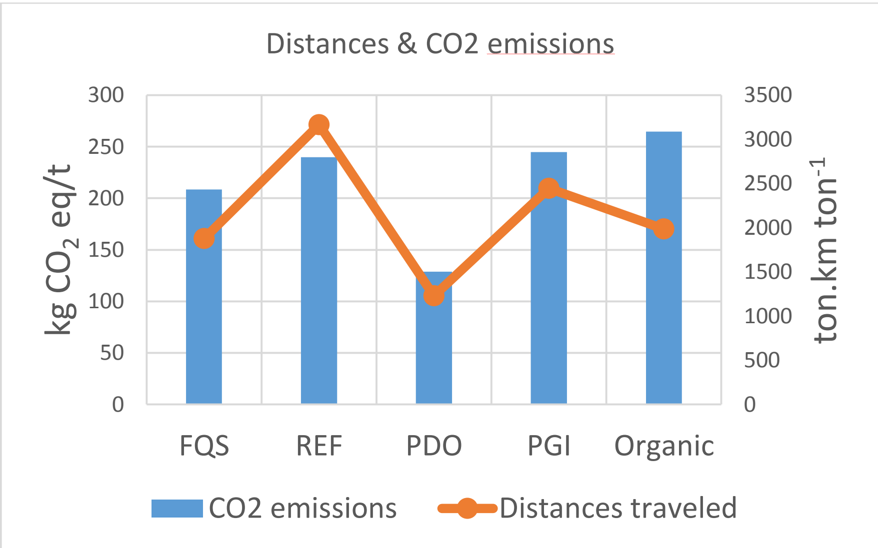



**Figure 18. Cross-analysis of both distances and emissions**

FQS products – or at least those studied here – are generally smaller in size (number of farms, number of processing units) compared to reference products. For this reason, the logistics may be less optimized (more empty running) and transport may rely to a larger extent on light goods vehicles that are more carbon-intensive per ton of product moved than heavy goods vehicles.

Therefore, shorter distances may lead to more emissions, indicating that variables other than the distance impact the level of emissions, namely the logistics and the transportation mode.

### *3.2.2. Discussion*

This section identifies the main drivers of the difference. The variables that impact distances travelled and $CO_2$ emissions from the transport stage are the following: the share of exports and the share of extra EU exports, the share of imports of raw products, the logistics (returning empty or single journey), the transportation mode (road, sea, air) and the energy (petrol, diesel), the product concentration, the value of the coproducts, and the technical specifications delimiting a particular geographical area.

#### 3.2.2.1. The larger the exports and the larger the extra European exports, the longer the distances, but not necessarily the higher the emissions

FQS final products are less exported than their reference, and also less exported outside Europe. The median value for FQS exports is 10% (against 17% for reference products) and the median value for extra EU exports is 7% (against 17% for reference products). These low median values indicate that most FQS products are sold on domestic markets, and that when they are exported, they are sold primarily in European markets. This applies to all types of FQS, except to PDO products that seem to be sold to a larger extent outside Europe (median value of 23%). Moreover, the sea food sector is clearly more export oriented, since half of the cases sold more than 60% of their production abroad, especially in European markets. This value is driven by the Norwegian cases that are highly export oriented, with 85% of PGI Lofoten stockfish and 98% of organic salmon sold abroad. Only a few other cases (PGI Kastoria apples and organic raspberries) are export oriented.

There are several reasons why FQS are less exported, and less exported outside Europe. First, lower label recognition, and therefore lower prices on foreign markets limit exports. This is the case of the PDO Zagora apples that benefits from a better label recognition and therefore better prices on the domestic market in Greece. Second, the volumes produced by FQS supply chains are generally lower, and may not be large enough so that opening international markets becomes a necessity, once domestic demand has been met. This is for instance the case of organic yoghurt. Third, the difference in taste of products and in consumers' preferences may explain why FQS is less exported outside Europe. For example, as the taste and the smell of the PDO Phu Quoc fish sauce are stronger, this product is primarily targeted to Asian neighbouring markets, while European and USA consumers have different preferences and may prefer the reference product.

These variables are expected to significantly impact the results, given that exports represent the main contribution to total distances and emissions. More exports, and more exports outside Europe, are expected to generate more miles and more emissions from the transport stage. Nevertheless, export miles may have different carbon intensity, according to the logistics and to the transportation mode used, especially for long distances entailed in extra EU exports (sea or air transport).

#### 3.2.2.2. The larger the imports of raw products and the longer the distances, the higher the emissions

Imports of raw products concern only a few cases (PGI Dalmatian prosciutto, PGI Gyulai sausage and its reference, and the reference paprika powder). For this reason, the mean contribution of this segment to food-miles and their associated emissions is small. Supply chains that rely on imports get 95 to 100% of their raw products abroad. Imports usually occur at the processing stage: meat parts from slaughterhouses located abroad to sausage or prosciutto producers located in the PGI country, conventional dried paprika from abroad to grinding and milling units in Hungary. Raw products are imported when they are cheaper when produced abroad, and when the technical specifications do not prohibit foreign procurement of core inputs. In the case of the PGI Dalmatian prosciutto, a particular quality of the meat is required to produce PGI prosciutto and imports of meat parts allow getting the appropriate quality at a lower price. On the other hand, conventional prosciutto is produced from local meat parts.

Imports of raw products are expected to drive distances and emissions up, all the more when raw products are further processed at destination. The difference with their reference appears all the larger when only the FQS supply chain relies on imports – for this reason, the PGI Dalmatian prosciutto is an outlier among our results.

#### 3.2.2.3. The more concentrated the product, the longer the distances and the higher the emissions embedded in the final product

The product concentration, measured with the transformation product ratio variable, provides an indication of the quantity of raw products required to obtain a unit of final product, either due to processing (eg. milk to cheese) or due to losses along the value chain (eg. mussels). The median value for product concentration of FQS products is 0.47 (against 0.54 for reference products), meaning that about 2 tons of raw products at farm level are required to get 1 ton of final product. FQS products are slightly more processed and concentrated than their references, but product concentration varies among sectors and types of FQS. PDO products show a far higher concentration (0.18), contrary to organic products that are less processed (0.75). Similarly, animal products are more processed and exhibit a high product concentration (0.29) while seafood products are much less concentrated (0.9). A higher product concentration is expected to drive distances and emissions up, since the miles and $CO_2$ emissions from an intermediate or final product are multiplied by the number of units of core inputs needed to obtain a given unit of this product over the distance between its processing plant and its core inputs providers. Some FQS products are clearly more concentrated than their reference (PDO Parmigiano Reggiano, PDO Sjenica cheese, PDO Phu Quoc fish sauce and organic pasta), whereas a few others are clearly less concentrated than their reference (PDO Sjenica cheese and PGI Thung Kula Rong-Hai Hom Mali rice).

#### 3.2.2.4. Transportation mode and logistics

The transportation mode (road, air, sea) and the energy use (petrol or diesel) impact the carbon intensity per kilometre travelled. Emission factors proposed by CoolFarmTool are clearly differentiated. Sea transport emits almost 50 times less $CO_2$ than air transport. Similarly, road transport is more carbon-intensive than sea transport, with a distinction between light goods vehicles (less than 3.5 tons) and heavy goods vehicles (more than 3.5 tons) – the latter being less carbon-intensive than the former.

National trips and exports within Europe usually rely on road transport, whereas exports outside Europe mainly rely on sea transport. Only some fresh and highly perishable products (mussels and yoghurt) rely on air transport, as well as products that are exported in very small quantities (in parcels), like Polish pasta. Therefore, imports within Europe are usually more carbon-intensive than exports outside Europe. For this reason, the longer distances resulting from oversea exports do not necessarily imply more emissions: long distance exports result in a less than proportional increase in $CO_2$ emissions. This result supports the idea that exports are not necessarily environmentally unfriendly, although they lead to longer embedded distances.

The logistics (retuning empty or single journey) impact the distance embedded in the final product, and to a lesser extent the emissions from the transport stage. Empty running back doubles the embedded distance but less than doubles the emissions released, given that empty vehicles emit less carbon per kilometre travelled than full ones. Logistics options concern road transport, as it is considered that sea and air transport are optimized and do not return empty. In this study, when no specific data is available, trucks are considered returning empty.

#### 3.2.2.5. PDO technical specifications delimit a geographical area for production and processing, therefore limiting distances and emissions

GI technical specifications may delimit a geographical area for production and processing. This is the case for all PDO and some PGI products. Indeed, although PDO products are more processed than other types of FQS, therefore exhibiting a higher median product concentration (0.18 vs 0.54), they involve much shorter distances (-60%, median value) and less emissions (-38%, median value) embedded in the final product. Moreover, PDO products are not significantly less exported (10% *vs* 17%, median values), and they are even more exported outside Europe than their references (23% *vs* 17%, median values). The only variable that seems to drive the difference in terms of distances and consequently, though to a lesser extent, in terms of emissions, is the delimitation of a geographical area for production and processing. This specificity of PDO products allows cutting distances travelled from farm to the processor gate, where product concentration multiplies the distances. Distances from farm to the processor gate are 36% shorter (median value) for PDO than for their reference, whereas they are 8% longer (median value) for all case studies, and up to 13% longer (median value) when considering distances from farm to the first processing level. The effect of geographical area delimitation is particularly clear-cut at processing level for PDO Bouchot mussels, PDO Zagora apples, PDO Sjenica cheese, and of course for PDO Kalocsai paprika powder whose reference relies on imports of core inputs.

#### 3.2.2.6. The more central the production and processing location within a country, the shorter the distances and the lower the emissions

Due to much shorter distances travelled on average on domestic market, this level has a limited contribution to total distances and emissions, compared to exports. However, given that domestic market is the main market, especially for FQS products (median value is 90%), the location of the production and processing units within a country directly impacts the distances travelled and the emissions released. Indeed, the main consumption basin of a country is assumed to be its largest cities. When no specific data is available, only the largest city is taken into consideration, with the postulate first that the largest city is also the largest consumption basin, and second that it may host national and international wholesale markets that then redirect goods into other regions. The fringe location of some productions, compared to their consumption areas, results in longer distances and more emissions on domestic market. For instance, the production basin of PGI Lofoten stockfish is located in a fringe area, in the Northern part of Norway, whereas the production area of its reference is closer to Oslo, its main consumption basin. As such, on domestic market, PGI Lofoten stockfish travels distances 3 times longer than its reference. While this seems a reasonable general assumption, it would be worth exploring the actual consumption basins which tend to be local, at least for GIs (Giraud et al., 2012).

#### 3.2.2.7. Methodological issues & limits

##### 3.2.2.7.1. Limits

As mentioned in section 3.2.2.4, when no data is available, trucks are considered returning empty, which leads to an empty running rate of 50%, meaning that 50% of all miles are done by empty trucks. This assumption is expected to overestimate the distances and emissions, since in Europe on average only 20% of all miles are done by empty trucks, and only 12.2% of miles from international trips are done by empty trucks. Country specific empty running rates are available and will be used to further refine results. This bias is expected to overestimate the contribution of the retail level, and especially of exports, to the total distances and emissions. Nevertheless, this bias affects equally results for the FQS and for the reference products, therefore cancelling the bias on the difference between FQS and its reference. As a consequence, only absolute values are affected by this bias, not relative values, which are those of interest in this study.

##### 3.2.2.7.2. System boundaries

The system boundaries retained for this study is theoretically from cradle to the end consumer, but in practice data are often available from farm to the first distribution level. Indeed, data referring to what happens before the farm gate are available only in 20% of cases. Similarly, data referring to what happens at the downstream part of retail level (from wholesalers to retailers, or even up to the final consumer) are available only in 12% of cases, with only 1 case study providing data up to the final consumer for some distribution segments. For exports, the capital cities of destination countries are used as destination points to compute distances, using Google Maps.

For this reason, the contribution of each level to the total distances and emissions is calculated on a different number of case studies, according to the level considered. Particular caution should be used for the farm and the downstream levels since data do not cover all sectors nor all types of FQS (animal sector and organic sector not covered).

##### 3.2.2.7.3. Data sources and reference products

Most data at processing level, from farms to processing units, come from field interviews of experts at processing level. Data on domestic market distribution are derived either from expert interviews as well or from product/sector specific national statistics. Data on exports usually stem from national statistics databases.

Table 16 synthetizes the reference products used for En2 analysis. These references may very across levels for a given case study.

| Case studied | Type of FQS | Country | Reference product |
|---|---|---|---|
| Buon Ma Thuot coffee | PGI | Vietnam | U3-P1 = conventional unsorted green coffee beans from Dak Lak province in Vietnam<br>P1-P2 = conventional sorted green coffee beans from Dak Lak province in Vietnam<br>P2-D1 = conventional ground and roasted coffee from Dak Lak province in Vietnam<br>Exports (P1-D1) = conventional sorted green coffee beans from Dak Lak province in Vietnam |

| | | | |
|---|---|---|---|
| Dalmatian prosciutto | PGI | Croatia | Conventional prosciutto made from pigs raised in Croatia |
| Saint-Michel bay bouchot mussels | PDO | France | U1-U3 = conventional Bouchot mussels in France<br>U3-P1 = conventional Bouchot mussels in France<br>P1-D1 = mussel sector in France<br>Exports = mussel sector in France |
| Olive Oil | PDO | Croatia | Conventional olives and conventional olive oil produced in Croatia |
| Comte cheese | PDO | France | U3-P1= national average from the cheese industry in France<br>Exports = Emmental cheese, France. |
| Camargue rice | Organic | France | U3-P1 = conventional rice from Camargue, France.<br>P1-D1 = conventional rice from Camargue, France.<br>Exports = conventional rice from France. |
| Gyulai sausage | PGI | Hungary | Conventional (generic) sausage from Gyulai region, in Hungary |
| Kalocsai paprika powder | PDO | Hungary | U1-U3 = conventional dried paprika from raw paprika produced abroad<br>U3-P1 = conventional dried paprika from raw paprika produced abroad<br>P1-D1 = conventional paprika powder<br>Exports = conventional paprika powder |
| Parmigiano Reggiano cheese | PDO | Italy | Biraghi cheese (similar non-PDO cheese) |
| Kastoria apples | PGI | Greece | Conventional apples produced by the cooperative Kissavos, in Agia, Greece |
| Zagora apples | PDO | Greece | Conventional apples produced by the cooperative Kissavos, in Agia, Greece |
| Phu Quoc Fish Sauce | PDO | Vietnam | Conventional fish sauce from Phu Quoc island in Vietnam |
| Organic pasta | Organic | Poland | Conventional cereals produced by the 14 model conventional farms |
| Organic pork | Organic | Germany | Conventional pork from Germany |
| Organic raspberries | Organic | Serbia | Conventional raspberries from Serbia |
| Sjenica cheese | PDO | Serbia | Conventional cow cheese produced in Serbia |
| Organic tomato from Emilia Romagna | Organic | Italy | U3-P1 = conventional processed tomato from Northern Italy (Emilia Romagna region).<br>P1-D1 = conventional processed tomato from Northern Italy (Emilia Romagna region).<br>Exports = processed tomato from Northern Italy (Emilia Romagna region). |
| Organic yoghurt | Organic | Germany | U3-P1 = natural cow milk yoghurt (unflavored) produced in Germany<br>P1-D1 = natural cow milk yoghurt (unflavored) produced in Germany (both conventional and organic)<br>Exports = natural cow milk yoghurt (unflavored and flavored) produced in Germany (both conventional and organic)<br>D1-D2 = natural cow milk yoghurt (unflavored) produced in Germany (both conventional and organic) |
| Opperdoezer Ronde potatoes | PDO | The Netherlands | Conventional fresh consumption potato from The Netherlands |
| Lofoten stockfish | PGI | Norway | P1-D1 = clipfish produced in More og Romsdal, Norway |

| | | | |
|---|---|---|---|
| | | | Exports = clipfish produced in Norway |
| Organic salmon | Organic | Norway | U3-P1 = conventional salmon in Norway<br>P1-D1 = conventional salmon in Norway<br>Exports = salmon in Norway |
| Sobrasada of Mallorca | PGI | Spain | U3-P1 = no data (assumptions)<br>P1-P2 = no data (assumptions)<br>Exports = Both PGI Sobrasada de Mallorca, Mallorca, Spain and PGI Sobrasada de Mallorca de Porc Negre, Mallorca, Spain |
| Ternasco de Aragon | PGI | Spain | Conventional lamb from Aragon region, in Spain |
| Thung Kula Rong-Hai (TKR) Hom Mali rice | PGI | Thailand | U2-U3 = conventional rice seeds, Thailand.<br>U3-P1 = conventional paddy rice produced in the TKR region, Thailand.<br>P1-D1 = conventional milled rice produced in the TKR region, Thailand.<br>Exports = conventional milled rice produced in the TKR region, Thailand. |
| Doi Chaang Coffee | PGI | Thailand | U3-P1 = conventional coffee cherries produced in Doi Phahee in Chiang Rai province, Thailand<br>P1-D1 = conventional roasted coffee beans produced in Doi Phahee in Chiang Rai province, Thailand |

**Table 16. FQS and corresponding reference products used in En2 analysis**

## 3.3. Water footprint of quality food

### *3.3.1. Results*

Water footprint comprises three fractions (indicators) that are green, blue and grey water footprint. Green water footprint is the amount of water that is needed to compensate for evapotranspiration (ETc). This latter process depends entirely on meteorological conditions, crop specific parameters as well as soil features. All these features allow to compute evapotranspiration for any given crop. When effective precipitation is higher than the ETc there is an excess precipitation and ETc corresponds to green evapotranspiration. When ETc is higher than the effective precipitation, evapotranspiration requirements must be fulfilled by irrigation and the green evapotranspiration correspond to the effective precipitation, which all goes to satisfy plant water requirement. That is green evapotranspiration is $ET_{c_{green}} = \min(ET_c, Eff\ rain)$ being the second factor the abbreviation for effective precipitation. The green component of the water footprint is finally calculated as:

$$WF_{green} = \frac{ET_{c_{green}}}{Y}$$

in which Y is yield in ton/ha.

The blue water footprint can be obtained from the so called blue evapotranspiration. It is estimated as the difference between the total crop evapotranspiration (ETc, see above) and the total effective rainfall. When the effective rainfall (from meteorological data) is greater than total crop evapotranspiration, $ET_{blue}$ is equal to zero. That is no water has to be added to the crop. When the effective rainfall is less than the total crop evapotranspiration what needed to satisfy plant evapotranspiration must come through irrigation (this fraction is called “irrigation required”). Of course this is the theoretical water needed by the crop. This value is then compared with the amount of water provided to the crop through irrigation. If no irrigation is applied, the blue water footprint is equal to zero, no matter if the crop needs water to balance the lack of rain and compensate for the evapotranspiration. When crops are irrigated the $ET_{blue}$ (blue water evapotranspiration) is assumed equal to the minimum between irrigation required and amount provided through irrigation. The total blue water evapotranspiration is obtained by adding all the $ET_{blue}$ fractions over the whole growing period and dividing it by the yield of the specific crop.

$$WF_{blue} = \frac{ET_{c_{blue}}}{Y}$$

The grey water footprint is an index of the impact agricultural production has on water bodies because of the pollutants used in the various processes (fertilizers, pesticides) and that may run off into the water. In this project, according to the international literature, we limited the analysis solely to the amount of nitrogen added with the fertilizers to quantify green water footprint. Also this choice was coherent with the fact that for certain productions it was difficult to obtain detailed data about other pollutant employed or parameters needed to make the computation. This latter makes use of (for every substance) of the following formula:

$$WF_{grey} = \frac{L}{c_{max} - c_{nat}} = \frac{\alpha \times Appl}{c_{max} - c_{nat}}$$

in which the quantity of nitrogen that reaches free flowing water bodies has been assumed to be 10 per cent ($\boldsymbol{\alpha = 0,1}$) of the applied fertilization rate (Appl, the amount of nitrogen applied in kg/ha/yr). The factor $\boldsymbol{c_{max}}$ stands for the maximum allowable concentration in the free flowing surface water bodies. As ambient water quality standard for nitrogen, we have used 13 mg/ lt (measured as N, Franke et al. 2013). $\boldsymbol{c_{nat}}$ is the natural concentration of the substance in the receiving body. The natural concentration in a receiving water body is the concentration in that would occur if there were no human disturbances in the catchment. For human-made substances that naturally do not occur in water $\boldsymbol{c_{nat} = 0}$. When natural concentrations are not known precisely but are estimated to be low, for simplicity one may assume $\boldsymbol{c_{nat} = 0}$. In this calculation we adopted the natural standard of 0,3 mg/lt (as suggested by Franke et al. 2013).

#### 3.3.1.1. The green water footprint has the greatest share of the indicator

The following chart summarizes the share of the indicator by each single fraction that composes it.

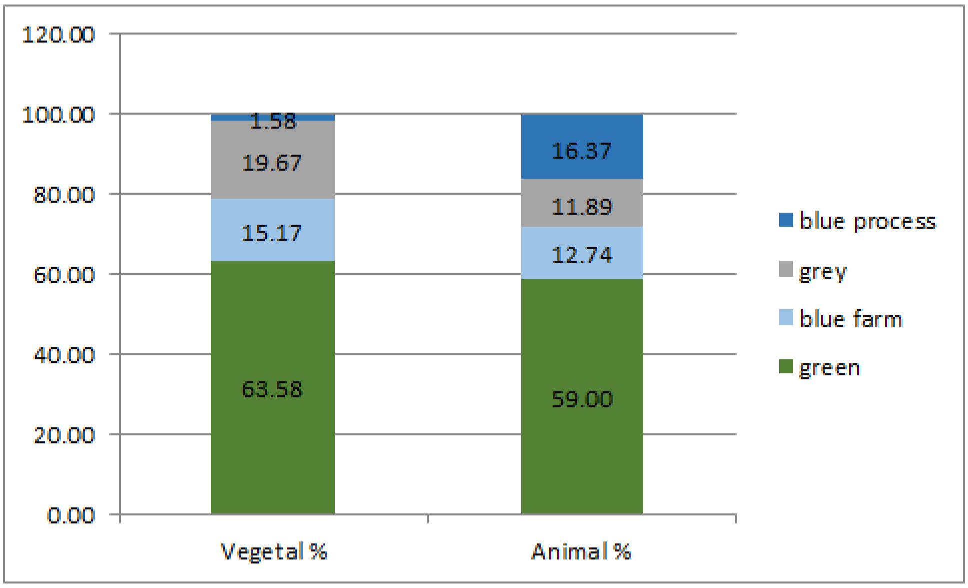



**Figure 19. Green, blue (farm and processing), grey water footprint as percentage share of the overall indicator.**

The green water footprint has the highest share of the indicator in both the vegetal and animal products. This summary refers to the percentages computed over the mean value of the indicators obtained by aggregating the values of FQS and REF. For every single product in fact both FQS and REF behave the same in terms of the share by the different fractions green, blue, and grey. Differences between FQS and REF products will be discussed more in detail later as for each single fraction.

#### 3.3.1.2 The comparison between FQS and their counterpart products

The following charts (Figures 20, 21 and 22) highlight the different performances between FQS and REF products as for vegetal products.

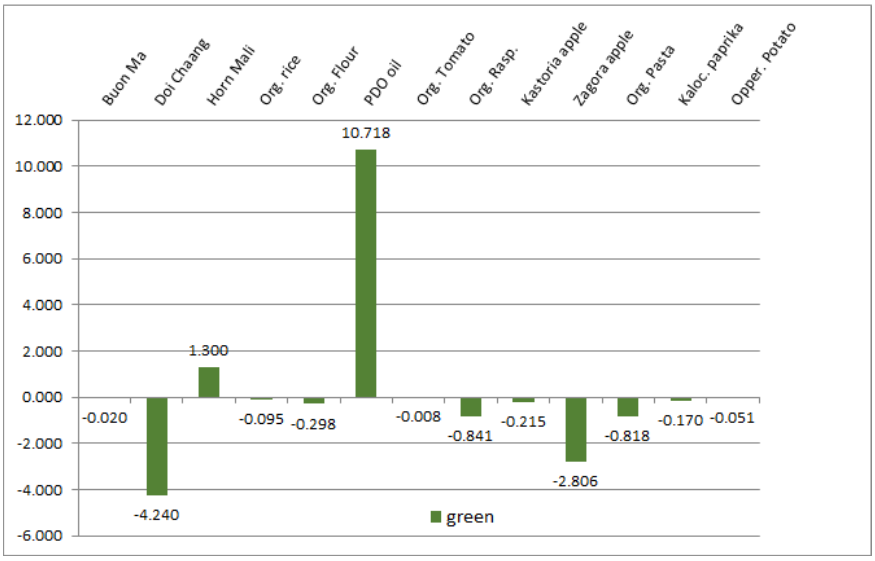


**Figure 20. Difference between REF and FQS (REF-FQS) performance in terms of green water footprint for vegetal products. Products for which FQS performs better than REF show positive values.**

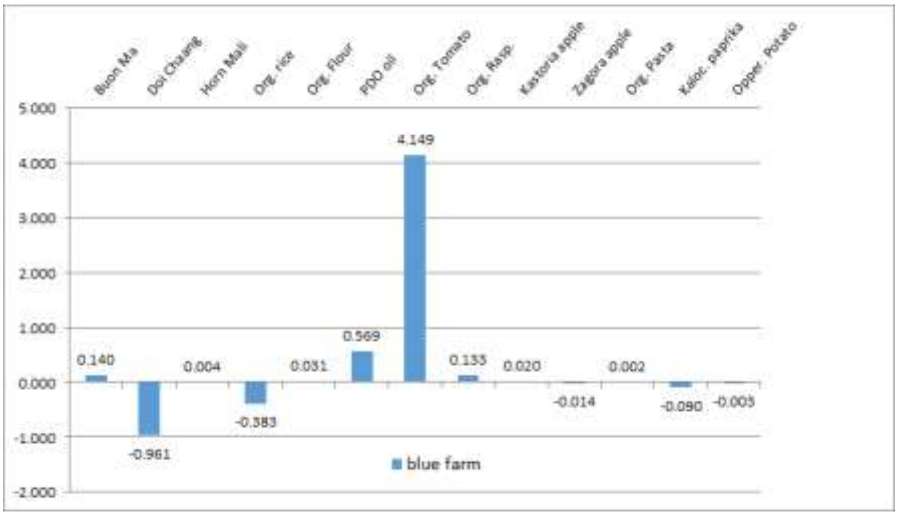



**Figure 21. Difference between REF and FQS (REF-FQS) performance as for blue farm water footprint for vegetal products. Products for which FQS performs better than REF show positive values.**

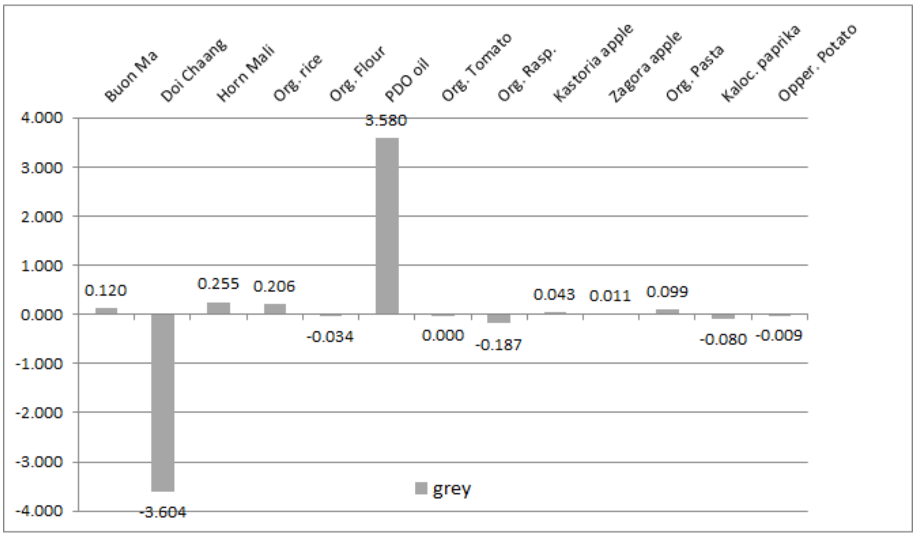



**Figure 22. Difference between REF and FQS (REF-FQS) performance as for grey water footprint for vegetal products. Products for which FQS performs better than REF show positive values.**

In the set of vegetal products FQSs perform better then REFs in terms of blue and grey water footprint. The opposite holds when we consider green water footprint. Considering green water footprint, among the products of the vegetal sector only the Horn Mali rice (Thailand) and the Olive oil (Croatia) (2 out of 13) have a lower water requirement than their counterpart. For all the other vegetal products, the balance for this sub-indicator is in favour of the reference product. Differences span from the lowest value of Organic Tomato (Italy) and Opperdoezer potatoes (The Netherlands) (-0.008 m3/kg, -0.051 m3/kg, respectively) to the highest difference which is -4.24 m3/kg obtained for PDO Olive oil (Croatia). Focusing on the blue water footprint at the farm level there are 8 products (out of 13) for which FQS performs better than the counterpart. They are: Buon Ma coffee (Thailand), Horn Mali rice (Thailand), Organic flour (Croatia), PDO Olive oil (Croatia) Organic Tomato (Italy) Raspberries (Serbia), Kastoria apples (Greece) and the organic pasta (Poland). FQS performs better as for grey water footprint in 7cases: Buon Ma coffee (Thailand), Horn Mali rice (Thailand), Organic rice (France), PDO Olive oil (Croatia), Kastoria apples and Zagora apples (Greece) and the Organic pasta (Poland). From these results it is not possible to highlight a clear pattern that helps discerning whether, in general, FQS products are more sustainable than REF as for water use.

Charts describing the results for the animal products are given in Figures 23, 24, 25.

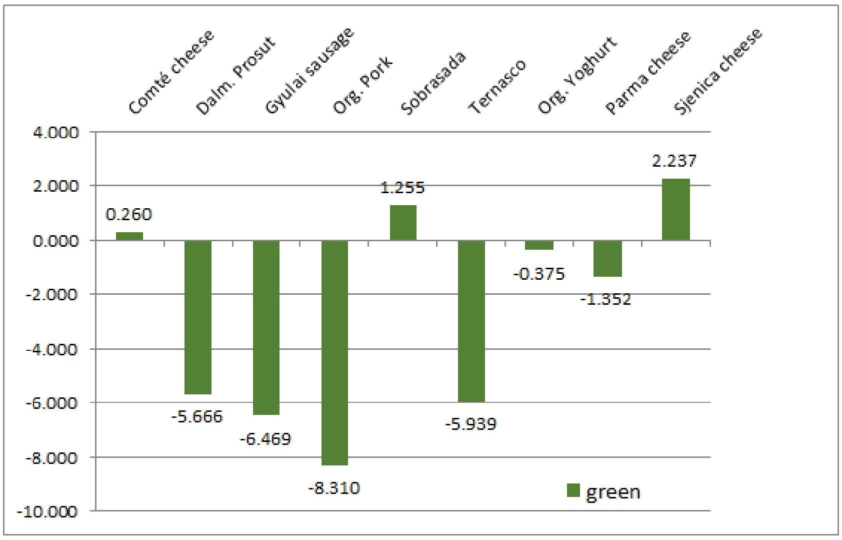



**Figure 23. Difference between REF and FQS (REF-FQS) performance as for green water footprint for animal products. Those for which FQS performs better than REF show positive values.**

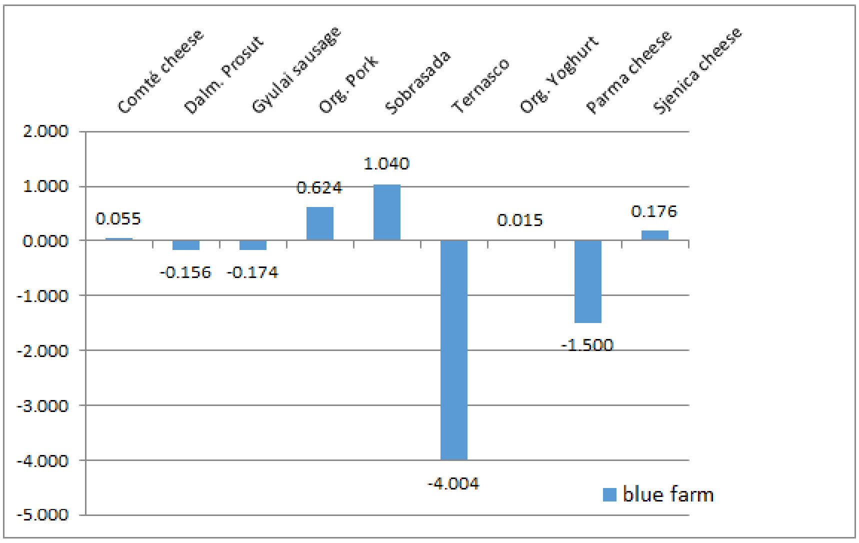



**Figure 24. Difference between REF and FQS (REF-FQS) performance as for blue farm water footprint for animal products. Those for which FQS performs better than REF show positive values.**

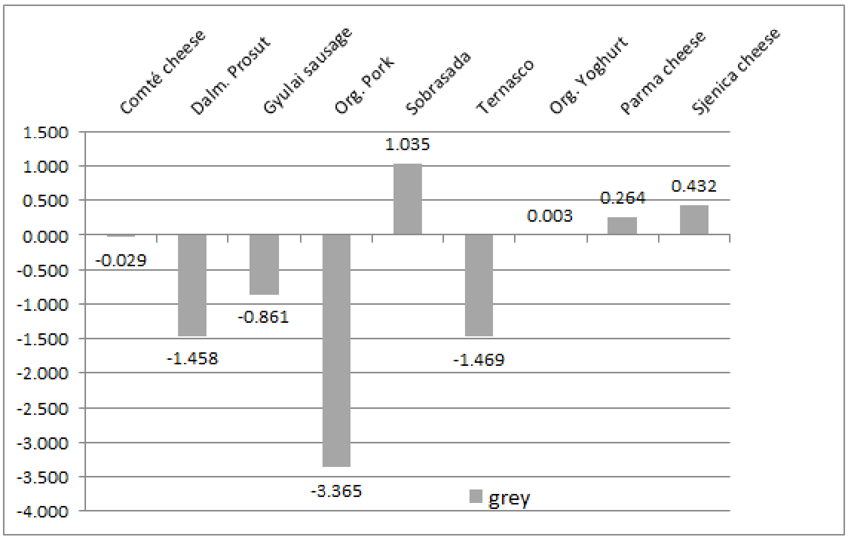



**Figure 25. Difference between REF and FQS (REF-FQS) performance as for grey water footprint for animal products. Products for which FQS performs better than REF show positive values.**

In the animal sector the majority of the FQS products show lower performance in terms of the green water footprint than their counterparts. Exceptions are Comté cheese (France), Sobrasada de pork negre (Spain) and the Sjenica cheese (Serbia) (3 out of 9).

As for the blue farm water footprint Comté cheese (France), Sjenica cheese (Serbia), Organic Yoghurt (Germany), Organic pork (Germany) and Sobrasada de porc negre (Spain) show lower values than their REF counterparts. The focus on the grey water footprint highlights that

Sobrasada (Spain) Sjenica cheese (Serbia), Organic Yoghurt (Germany) and Parmigiano (Italy) shows a lower impact than their REF counterparts.

#### 3.3.1.3 The determinants of the differences

Estimating the green, blue and grey water footprints of growing a crop requires a large amount of data. In general it is always preferable to find local data pertaining to the crop field location. In many cases it is too laborious to collect location-specific data given the purpose of the assessment. In the lack of specific data one can decide to work with data from nearby locations or with regional or national averages that may be more easily available. In this analysis we often referred to default data for meteorological information, soil and crop parameters. This necessarily introduced a certain degree of approximation and imposed uniformity in the sense that same data had to be used for both FQS and REF productions and this cancelled out potential differences that climate, crop and soil features generate at local scales. In several cases we had to use default values extracted from data sets already available (national data bases, scientific publications). For each product similarities and differences as for parameters used are signalled in the specific reports. Considering green water footprint the computation is exclusively performed using CROPWAT, the software suggested by the FAO to compute crop evapotranspiration. The software requires input data about meteorological conditions taken from the meteorological station that is the closest to the production area; about crop features (crop growth parameters) as well as soil features. Differences in all these parameters determine the different behaviour of FQS and REF productions. In case of similar data (same meteorological conditions, crop parameters) one main driver for the green water footprint is crop yield. This descends directly from the formula by which this indicator is computed (see Par. 3.3., above) and that divides the green evapotranspiration obtained from CROPWAT by the crop yield. It follows that the highest the yield the lower the green water footprint, as the water footprint must be computed per unit of production.

This "per unit yield" approach is the one commonly accepted (it is internationally agreed, see the site of the water footprint network: https://waterfootprint.org/en/) for communicating the impact of production on water resources. There is a growing interest for this impact to be calculated using a "per hectare" approach, because certain systems tend to reduce the production per unit surface (among others through a stronger link to the soil), a crucial issue for water management institutions. We did not apply this latter approach for two reasons: the first is that, as said, it is internationally accepted that water footprint is a "per unit" indicator, which reflects the fact that it is the selling commodity the final goal of any production and for which water is used. The second, connected to the first, considers what sustainability is all about. If production per unit surface (ha) decreases, this also applies to the impact on water resources but only if yield also decreases. This is not among the prime objective of any economic enterprise. If yield has to remain the same, the area of production must be enlarged. The impact per unit surface decreases but the impact to obtain the final product remains the same.

Blue water footprint at the farm level is estimated as the difference between the total crop evapotranspiration and the total effective rainfall. When the effective rainfall (from meteorological data) is greater than total crop evapotranspiration, the blue water footprint is equal to zero. That is no water needs to be added to the crop. When the effective rainfall is less than the total crop evapotranspiration what needed to satisfy plant evapotranspiration must come through irrigation (this fraction is called "irrigation required"). Of course this is the theoretical water needed by the crop. This value is then compared with the amount of water provided to the crop through irrigation (specific data). If no irrigation is applied, the blue water footprint remains equal to zero, no matter if the software CROPWAT tells us that the crop needs water to balance the lack of rain and compensate for the evapotranspiration. When crops are irrigated the so called blue water evapotranspiration is assumed equal to the minimum between irrigation required and amount provided through irrigation. The total blue water evapotranspiration is obtained by adding all the fractions over the whole growing period of each crop and dividing it by the yield of the specific crop.

To compute the grey water footprint the volume of polluted water has been estimated using nitrogen (N) as a representative element for estimations of the grey water footprint according to Chapagain et al. (2006). Information about the different quantities of nitrogen (both organic and mineral) in the various case studies was sufficiently detailed to allow computing the grey water footprint. In general the amount of nitrogen fertilizers determined the difference in the performance between FQS and the counterparts. Nonetheless yield may reverse the impact in favour of the cultivar for which more fertilizer is used. It has to be noted that in computing the grey water footprint the important data is the amount of nitrogen used. The distinction between organic and mineral is important only in the LCA phase (see below) in which we computed the amount of water consumed in the production and spreading of fertilizers. But this affects the value of the indicator in a minimal part. Pesticides as well should be considered in the assessment of the grey water footprint. However, given the difficulties to obtain the data necessary to compute their impact we only took into account their impact in the LCA approach.

Besides yield, among the main determinants that played a relevant role in the differences between FQS and REF one is the proportion of the different crops in the diet of the animals (for animal productions only). For the most part of the animal products the diet used to feed animals is a combination of different crops: some grown locally some others imported. Each of these crops has its own impact on water resources. A reduced water footprint can be obtained if a crop with a lower impact on water resources enters in the diet of the animals in greater amount than other crops characterized by higher impact. Finally, for both vegetal and animal productions, another major determined that contributed to differentiate the performance of the FQS and REF products is the final product ratio, the measure of the efficiency at which initial prime products are converted in their final form.

#### 3.3.1.4 The water footprint of the overheads: the LCA approach

The impact on water resources of food productions was considered also in that part which is due to the so called overheads. That is water consumption imposed by the various activities in support of the production. Production of diesel fuel requires water; fertilizers and pesticides production requires water; electricity used in farms presupposes consumption of water. All these fractions are difficult to assess and the only possibility to know or predict them is to apply a LCA approach. For each product the amount of pesticides applied, of fertilizers, the energy consumption, the fuel required were considered as input to the LCA system that was created for each product. The LCA made use of the Ecoinvent data bank which provides the information about the quantity of water that is consumed in a process that renders one unit of the issue that was considered as an input to the production process. This allowed refining the calculation of the water footprint. Nonetheless this fraction of the water footprint (and which contributes to it as blue water footprint) resulted very small for the majority of the products so that its contribution to the final value of the indicator is minimal.

# 4. Social impact of FQS and its determinants

## 4.1. Labour: its intensity, its productivity, level of skill and social capital

We assume that FQS can contribute to individual livelihoods and to social sustainability of their local communities by providing employment and encouraging upskilling. Through employment, such supply chains would counter the urban migration trend affecting rural regions, and help retain (economic) capital in the local region. Indeed, in contrast to the conventional economic logic of greater efficiency when less employees generate more revenue, we suggest that businesses which provide greater employment may be more socially sustainable. Separately, by requiring a higher-level of quality and hence skills, FQS may encourage greater local educational attainment, or encourage skilled immigration.

### *4.1.1. Results*

#### 4.1.1.1. FQS products seem to outperform their references

Figure 21 shows the distribution of FQS performance relative to their reference products. In general, the positive skew indicates that FQS products tend to outperform their references. In most cases, FQS performances range from comparable with their reference products to 50 to 100% higher. While there are cases where FQS underperform, the magnitude of their underperformance is much less than their positive performances.

Labour-to-production ratio is the highest performing indicator, and has the most positive outliers, showing the FQS are likely to use (and employ) much more labour than their counterparts. The educational attainment of workers in food quality schemes had the least difference, and more often negative performance, compared to reference products, suggesting that FQS may not encourage (or correlate) with educational outcomes.

However, statistical significance was calculated by the Kruskal-Wallis test, which is a non-parametric test to compare samples from two or more groups of independent observations. This test was selected because it does not require the groups to be normally distributed and is more stable to outliers. P-values <0.05 were considered as significant. The results show that the difference between FQS means and reference means, as well as between medians, are not statistically significant.

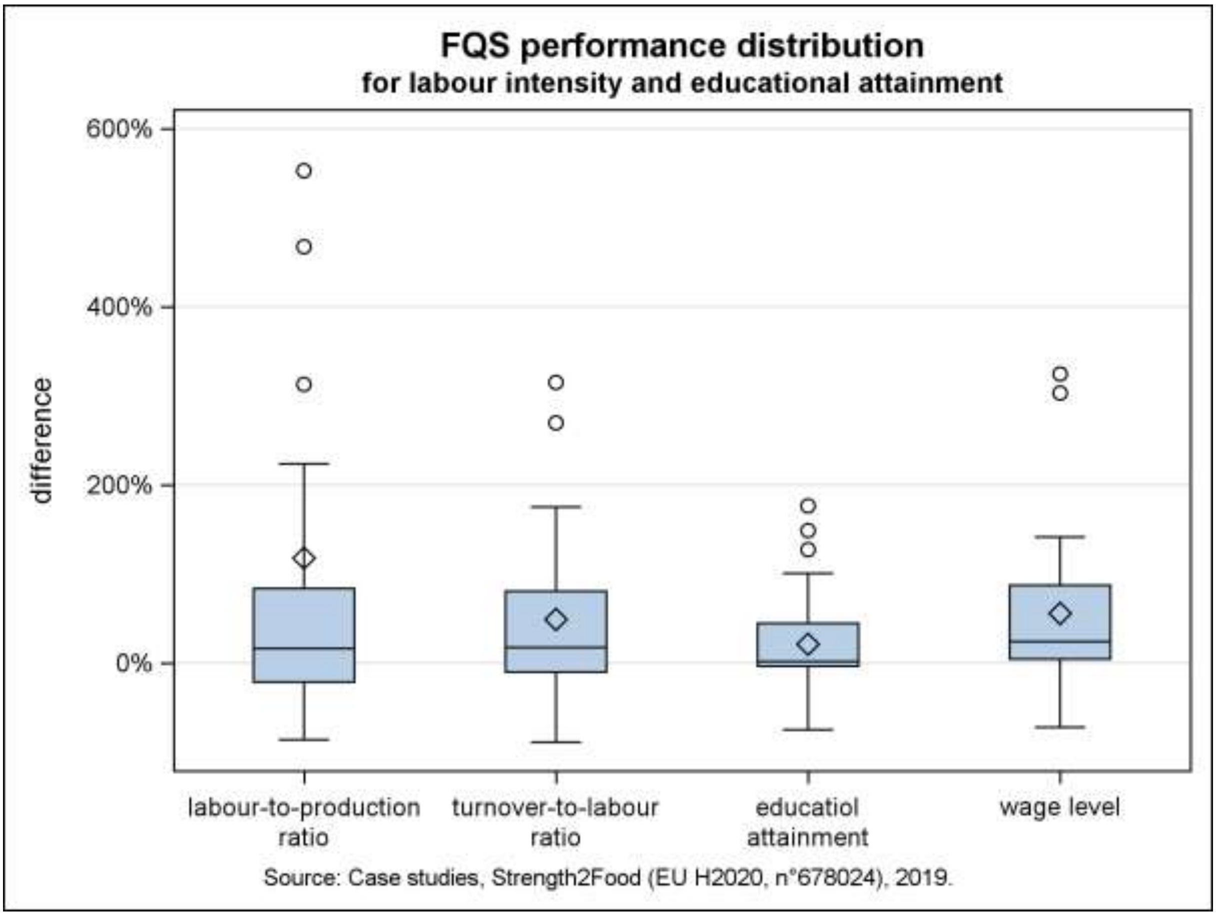



**Figure 21. Distribution box plot of FQS performance for each indicator compared to reference products.**

The bottom and top edges of the box indicate the intra-quartile range (IGR), values between the first and the third quartiles. The line inside the box indicates the median value and the marker (lozenge) the mean value. The whiskers that extend from each box indicate the upper and lower fences (± 1.5 IQR). Circles indicate outliers, the observations that are more extreme than the upper and lower boundaries. Note that one extremely positive outlying data point (labour-to-production ratio for Sjenica cheese [1536%]) is not included to improve readability.

##### 4.1.1.2. Organic products seem to outperform PDO, and PDO products outperform PGI

Table 16 provides further detail on the performance of food quality schemes for each indicator, including a breakdown by sector and position in the supply chain. The breakdown by type of FQS (i.e. organic, PDO or PGI) shows that, in general, organic products outperform PDO products, which in turn outperform PGI products.

Excluding education, the benefits of these FQS primarily, or more extensively, benefit actors involved in the processing of food products, rather than farmers (except for PGI). By contrast, educational benefits sole accrue to farm level, although such benefits are generally small compared to their references. At a sectoral level (i.e. animal, seafood or vegetal products) there are few clear trends.

| FQS | Grouping | Labour-to-production ratio | Turnover-to-labour ratio | Educational attainment | Wage level<br>median [min, max] (#) |
|---|---|---|---|---|---|

| | | median [min, max] (#) | median [min, max] (#) | median [min, max] (#) | |
|---|---|---|---|---|---|
| **Organic** | **Overall** | 41 [-45; 896] (8) | 37 [-56; 225] (8) | 2 [-20; 153] (6) | 63 [-3; 144] (6) |
| | Animal | 41 (3) | 115 (3) | 0 (1) | 24 (2) |
| | Seafood | N/A | N/A | N/A | N/A |
| | Vegetal | 41 (5) | 35 (5) | 5 (5) | 102 (4) |
| **PDO** | **Overall** | 18 [-57; 1555] (8) | 15 [-93; 147] (8) | 9 [-50; 284] (8) | 17 [-59; 626] (8) |
| | Animal | 29 (3) | 18 (3) | -5 (3) | 33 (3) |
| | Seafood | 19 (2) | 15 (2) | 107 (2) | 4 (2) |
| | Vegetal | -10 (3) | 27 (3) | 8 (3) | 13 (3) |
| **PGI** | **Overall** | 10 [-86; 577] (10) | 6 [-74; 595] | 0 [-75; 350] (10) | 7 [-81; 661] (10) |
| | Animal | 224 (4) | -64 (4) | -8 (4) | -64 (4) |
| | Seafood | 16 (1) | 175 (1) | -44 (1) | 35 (1) |
| | Vegetal | 8 (5) | 10 (5) | 44 (5) | 8 (5) |

**Table 17. Median [min; max] relative differences in performance (in percentage, rounded up) between case studies in selected groupings and their reference products, for each indicator.**

#### 4.1.1.3. Where FQS performed better than their references, PGI products records the best differences

Table 17 shows the proportion of cases for each FQS and grouping where FQS products outperformed their references. As found above, organic products outperform PDO products. In contrast to the previous table, here, PGI products record the best differences. The wage level indicator shows the only clear trend between stages of the supply chain, with the processing stage having a systematic greater difference than the farm level. At a sectoral level, vegetal summary (products including fruit, cereals, etc.) have a high performance for education attainment and wage level, while animal products have a high proportion of higher labour usage cases. Other sectoral trends are not identifiable.

| FQS | Grouping | Labour-to-production ratio<br>median [min, max] (#) | Turnover-to-labour ratio<br>median [min, max] (#) | Educational attainment<br>median [min, max] (#) | Wage level<br>median [min, max] (#) |
|---|---|---|---|---|---|
| **Organic** | **Overall** | 60 [0; 896] (6) | 50 [6; 225] (7) | 5 [0; 153] (4) | 79 [24; 144] (6) |
| | Animal | 60 (3) | 115 (3) | 2 (0) | 42 (2) |
| | Seafood | N/A | N/A | N/A | N/A |
| | Vegetal | 54 (3) | 37 (4) | 6 (4) | 102 (4) |
| **PDO** | **Overall** | 34 [12; 1555] (6) | 69 [15; 147] (5) | 22 [3; 284] (5) | 28 [2; 130] (8) |
| | Animal | 34 (2) | 50 (2) | 8 (1) | 35 (2) |
| | Seafood | 27 (2) | 43 (1) | 107 (2) | 11 (2) |
| | Vegetal | 163 (1) | 110 (2) | 22 (1) | 24 (3) |
| **PGI** | **Overall** | 42 [8; 577] (7) | 62 [1; 595] (5) | 48 [3; 350] (4) | 35 [1; 661] (7) |

| | | | | | |
|---|---|---|---|---|---|
| | Animal | 224 (3) | 7 (1) | N/A | 324 (1) |
| | Seafood | 105 (1) | 175 (1) | N/A | 35 (1) |
| | Vegetal | 10 (2) | 35 (4) | 48 (4) | 9 (5) |

**Table 18. Median (min, max) relative differences in performance, for selected groupings, where FQS performed better than their references.**

### *4.1.2. Discussion*

#### 4.1.2.1. Educational attainment

The quantitative analysis above shows no clear link between FQS and greater (or lower) education attainment by actors in the supply chain. Furthermore, a detailed examination of the case studies shows no clear trend between case study characteristics and over or underperformance. Both high and low performing cases occur in relatively poorer and wealthier countries (which generally correlate to overall education levels), across large and small volumes of production, when there is high or low technology usage, across different supply chain organisations, and across similar regulatory models. The only consistency observable is that high FQS performance is generally at the supply chain level of producers, while underperformance is across producers and processors. There may also be systemic data issues, particularly around underperformance, especially as many case studies use broad (often, national) statistics for reference products. Overall, educational attainment appears to be a coincidence of particular case studies, and unrelated to the products or their use of quality schemes.

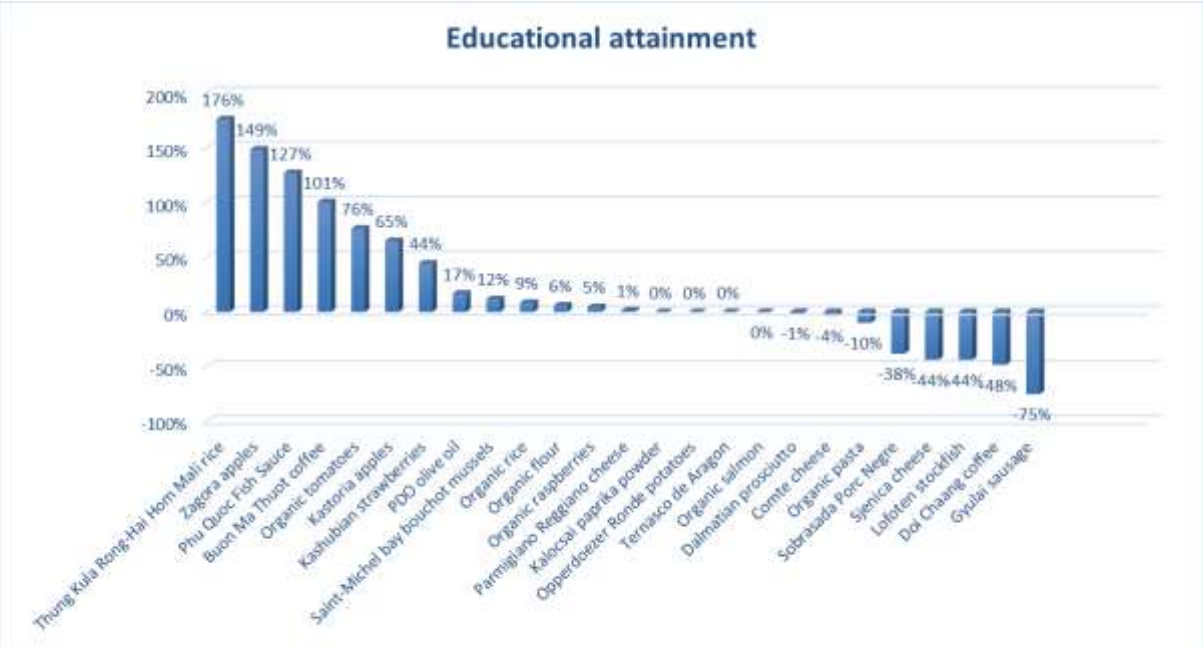



**Figure 22. Histogram of relative differences in performance, measured by educational attainment, for each case study.**

#### 4.1.2.2. Labour to production

The FQS examined generally have a higher to much higher labour usage (labour-to-production ratio) compared to reference products, indicating that they provide greater employment. This appears to be driven by, and particularly noticeable in, products produced by large numbers of small (often, family) farms, as they do not make use of reduced labour through economies of scale. However, some cases, particularly at the processing level of the supply chain, can also be driven by labour-intensive processing standards. However, these cases are not unique to any particular quality scheme examined. Indeed, underperforming cases (i.e. low labour use), driven by concentration and vertical integration for economies of scale, are found across organic, PDO and PGI cases. No other key drivers are identifiable, with high and low performing cases located in many different countries, sectors and across different product types. Again, it is important to note that some of these conclusions may be linked to assumptions about reference products.

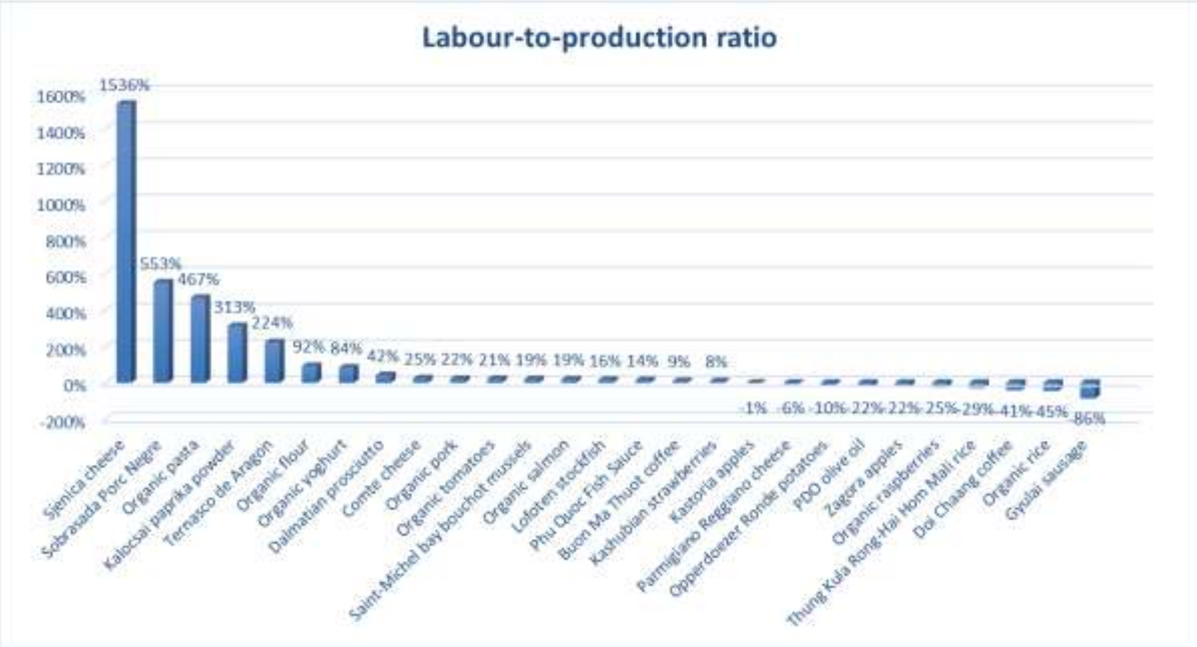



**Figure 23. Histogram of relative differences in performance, measured by labour to production ration, for each case study.**

#### 4.1.2.3. Turnover to labour ratio

The efficiency of employees in FQS (i.e. how much turnover/profit is generated per employee) is generally equal to or higher for FQS compared to reference products. It can be assumed that high performing FQS could be characterised by integrated supply chain structures featuring large co-operatives or vertically integrated businesses, allowing efficiencies to be developed. In some cases, the FQS products are also highly valued by consumers, increasing the profit compared to the reference products while labour requirements may also be high (labour-intensive specialty products) or remain similar (efficient production and highly valued products). Underperforming FQS products are characterised by a dominance of small farms, leading to labour inefficiencies, or strict products standards that are not valued by consumers. No other consistent factors are identifiable.

#### 4.1.2.4. Wage level

Wage levels are also generally higher in FQS compared to reference products. However, the drivers behind this are difficult to establish and interpret. The processing level of the supply chain in general shows the highest performance for this variable, which may indicate that FQS specialty products require more specialised processing skills and hence higher wages (although it may also indicate that FQS use less labour or have higher turnover than reference products). This is for example the case for Parmigiano Reggiano and Comté cheese where the share of skilled cheese-makers among total processing firm's workforce is higher than for their reference products. There is some indication of country-specific trends, such as high performance in Italy, which may be driven by the lack of a legislated minimum wage (i.e. reference products may require low skills and hence be paid very poorly). There are also both high (processing level) and low performance (farm level) cases in Thailand, indicating high inequalities between different levels of the supply chain, which may also be related to low minimum wages and skilled processing requirements. Underperforming cases are particularly hard to interpret, as common sense indicates that FQS products would at least be equal to references, rather than below. Potentially, reference products may be highly automated and so require higher skills and hence wages to operate. It is also possible that the use of broad (often, national) statistics for reference products obscures the reduced wage effect of poorer regions, where underperforming cases may be located.

## 4.2. Governance and bargaining power distribution

### *4.2.1. Bargaining power and the social sustainability advantage of FQS supply chains*

An analysis of a supply chain's social sustainability built on our indicator rests on the assumption that supply-chains' social sustainability is bi-dimensional. The first dimension relies on the ability to even out bargaining power along the different levels of the supply chain (our indicator does not consider bargaining power distribution between competitors). As our indicator builds on a normalized Herfindahl coefficient, values close to zero are associated with very even bargaining power distributions, while values close to one are associated with highly uneven bargaining power distributions.

The second dimension rests on a supply chain's capacity to resist to external (substantial change in market or production conditions…) or internal (entry of new competitors, exit of a substantial player) perturbations. One can assume that supply chains whose actors collectively show "strong" bargaining power would be able to better accommodate disruptive change. In supply chains counting several levels, a straightforward way of evaluating such a resistance consists in identifying and in evaluating the resistance of the weakest level. Table 18 provides the list of supply chains serving as data sources for our analysis.

| Case studied | Type of FQS | Country | Reference product |
|---|---|---|---|
| Buon Ma Thuot coffee | PGI | Vietnam | Non-PGI coffee from Dak Lak province in Vietnam |
| Saint-Michel bay bouchot mussels | PDO | France | National average (TSG Bouchot mussels) |
| Comte cheese | PDO | France | National average (cow cheese) |
| Camargue rice | Organic | France | Non-organic rice (mostly PGI) |
| Gyulai sausage | PGI | Hungary | Non-PGI sausage produced in Hungary |
| Kalocsai paprika powder | PDO | Hungary | Imported paprika milled in Hungary |
| Parmigiano Reggiano cheese | PDO | Italy | Biraghi cheese (similar non-PDO cheese) |
| Kastoria apple | PGI | Greece | Kissavos apples (non-GI apples from another region) |

| | | | |
|---|---|---|---|
| Phu Quoc Fish Sauce | PDO | Vietnam | Non-PDO fish sauce from same region |
| Organic flour | Organic | France | National average |
| Organic pasta | Organic | Poland | National average |
| Organic pork | Organic | Germany | National average |
| Organic raspberries | Organic | Serbia | National average |
| Organic tomato from Emilia Romagna | Organic | Italy | National average |
| Organic yoghurt | Organic | Germany | National average |
| Sobrasada of Mallorca | PGI | Spain | National average |
| Ternasco de Aragon | PGI | Spain | Non-PGI lamb in the same region (Aragon) |
| Thung Kula Rong-Hai (TKR) Hom Mali rice | PGI | Thailand | National average |

**Table 19. FQS and corresponding reference supply chains used in our analysis**

Figure 24 shows the position of FQS supply chains (red dots) and their counterparts (blue squares) along both the bargaining power distribution (horizontal) and the bargaining power "strength" (vertical) axes. An inspection of Figure 24 shows that supply chains can be grouped into three profiles.

The first profile is comprised of supply chains characterized by an uneven vertical distribution of bargaining power combined with low bargaining power. They can be considered as "poorly sustainable" for several reasons. First, when bargaining power is unevenly distributed along the supply chain, created value is more likely to fall into the hands of more powerful stakeholders and weaker levels would then only seize a small share of value (Crook and Combs, 2007). Second, supply chains for which levels are characterized by low bargaining power can be considered as vulnerable to changes affecting the supply chain, whether those changes come from internal or external factors. In the case of substantial changes affecting a supply chain, the choice of alternative governance modes and the capacity to evolves becomes more restricted as actors are characterized by low bargaining power (Argyres and Liebeskind, 1999).

A second profile, qualified as "fair but instable", groups supply chains characterized by a well-distributed bargaining power and, in the same time, by low bargaining power value for the weakest level. By managing an even distribution of bargaining power along its different levels, it is expected that value generated at the chain level can be fairly distributed along the different levels. But, this equilibrium is unstable and can be easily challenged by any substantial changes affecting the supply chain. Indeed, actors of the weakest level have only limited possibility to respond and adapt to those changes, due to their low bargaining power.

A third profile is coined as "sustainable", which are supply chain combining both a well distributed bargaining power and strong bargaining power for the weakest link. Those supply chains can be considered as sustainable because they are able to simultaneously achieve a static fair equilibrium between actors of different levels with their capacity to resist and adapt to changes in affecting the supply chain.

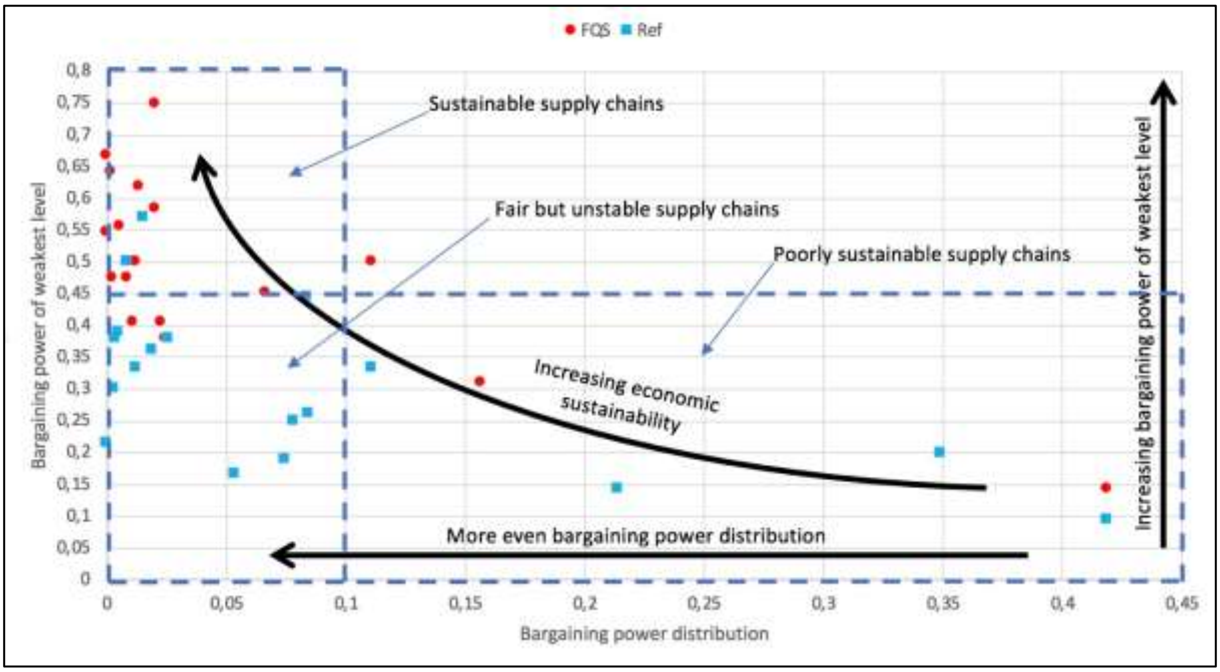



**Figure 24. Bargaining power profiles of FQS (red dots) & of reference (blue squares) supply chains.**

| | FQS | Reference |
|---|---|---|
| Sustainable supply chains | 11 | 2 |
| Fair but unstable supply chains | 3 | 12 |
| Poorly sustainable supply chains | 3 | 4 |
| Outliers | 1 | 0 |

**Table 20. Distribution of FQS and of reference supply chains along the three profiles**

A closer examination of the composition of each profile shows that FQS are clearly more represented in the group of "sustainable supply chains" than references (11 FQS vs. 2 references) (see also Table 19). On the other hand, reference supply chains are more represented in the group of "fair but unstable supply chains" (3 FQS vs. 12 reference). Finally, the group of "poorly sustainable" supply chains sees a balanced distribution between FQS and of reference supply chains (3 FQS & 4 reference) and one FQS supply chain does not correspond to any of the aforementioned profiles and can therefore be considered as an outlier. Figure 24 gives first evidence that FQS can globally be considered as socially more sustainable than conventional counterparts, but this higher sustainability only partly builds on their capacity to more evenly distribute bargaining power among levels. Rather, according to our results, a key determinant of their social sustainability lies in the capacity to resist and accommodate potential perturbations, as evidenced by the fact that FQS tend to reach higher bargaining power scores. This intuition is confirmed when comparing two-by-two FQS and corresponding references (cf. Table 20).

| | Bargaining power distribution | Bargaining power value of the weakest level | Both dimensions |
|---|---|---|---|
| Substantial advantage of the FQS over the reference | 6 | 12 | 6 |
| No substantial advantage | 10 | 6 | 4 |
| Substantial disadvantage of the FQS over the reference | 2 | 0 | 0 |

**Table 21. Comparison of FQS and corresponding references supply chain along bargaining power dimensions**

It is here considered that a FQS supply chain enjoys a substantial advantage on any of two dimensions when score differences with corresponding references exceeds 0,05 in absolute value[3]. There is no substantial advantage when score differences are less than +/- 5%. Results in Table 20 show that six out of eighteen FQS supply chains are characterized by a more even bargaining power distribution than their conventional counterparts. In the same time, twelve FQS supply chains witness higher bargaining power values. Finally, six cumulate a substantial advantage in both dimensions. On the other hand, only two FQS supply chain are substantially disadvantaged over their reference on bargaining power distribution and none of them are characterized by lower bargaining power. Besides, most supply chains for which the FQS does not provide any substantial advantage on any two dimensions (i.e. Saint Michel Bouchot mussels, Organic Camargue Rice, Organic flour) have the particularity of being closely related with the reference supply chain, either because it is a "spin-off" supply chain, or because stakeholders in the FQS (producers or processors) are also active in both chains.

All in all, one can conclude out of those results that FQS supply chains globally achieve higher social sustainability than reference counterparts. This sustainability advantage partly relies on their capacity to achieve more even vertical distribution of bargaining power and partly on the capacity of levels to show resilience against possible changes. Next development will try and identify factors underlying the social sustainability advantage of FQS by drawing a distinction between competition-based, transactional and institutional factors.

### *4.2.2. Identifying factors underlying FQS' social sustainability*

This section focuses on FQS supply chains, in order to identify the factors underlying their social sustainability advantage over references. In so doing, we draw a distinction between different types of factors, each corresponding to different categories of variables:

- Competition based. This category of variables accounts for the degree of concentration in a given level of the supply chain. The more the level is concentrated, the more likely it becomes for actors of the level to weight in during the negotiation with upstream and downstream levels.

[3] Due to the structure of the bargaining power distribution indicator, a FQS supply chain is considered as having a substantial advantage when score difference with corresponding reference is less than -0.05. When considering bargaining power positions, a FQS supply chain is considered as having a substantial advantage over corresponding supply chain when score difference is more than 0.05.

- Specificity of skills and products. Those variables account for the capacity of players to mobilize specific resources and capabilities for contributing for a highly specific end-product. As for competition-based variables, a higher contribution for the specificity of the end-product is assumed to increase bargaining power.
- Institutional variables. This category of variables accounts for the capacity of actors to at a given level to coordinate and to collectively weight in negotiation processes. Developing coordination spaces such as professional or supply chain unions increase their capacity to settle common institutions (e.g. rules and inter-organizational routines) (Keeble et al., 1999).

Table 21 counts the number of supply chains characterized by high average scores (higher than the median score) for each category of variables at all levels. For instance, the value of two attributed to FQS for competitive framework variables corresponds to the fact that two FQS supply chains show high average scores for this category of variables at all levels. This statistic accounts for two effects. It first accounts for a fair distribution of bargaining power. Second, it accounts for a high contribution to bargaining power at all levels.

| | FQS SC (18 SC in total) | Reference SC (18 SC in total) |
|---|---|---|
| Competitive framework | 3 | 0 |
| Specificity of skills and products | 11 | 2 |
| Institutional framework | 13 | 9 |
| At least two categories | 7 | 1 |

**Table 22. Split of contribution to bargaining power strength and fair distribution after variable categories**

Out of Table 21, one can see that the institutional framework is the most regular contributor for both types of supply chains. This means that “institutional thickness” (Amin and Thrift, 1993), which increases the capacity of actors to settle collective rules and strategies, plays the most important role, not only for promoting fair negotiations among the different levels composing supply chains, but also through their capacity to collectively adapt to disruptions affecting them. Besides, as it is cited 13 times for FQS, for only 9 times for references, the institutional framework can be considered as “thicker” for the former than for the latter, which means that FQS stakeholders enjoy larger negotiation spaces. Specificity of skills and products also plays a substantial role for FQS while, it can be considered as marginal for references. Furthermore, the characteristics of the competitive framework appears only to play a marginal role in FQS and any role in references. Finally, seven out of eighteen FQS supply chains show high contributions of at least two different categories. This result highlight that their advantage relies on a combination of factors conducive to their sustainability, which are linked to their capacity to develop a rich institutional framework, as well as to ensure for the specificity of the end-product and that all level contribute to it. By way of contrast, references only rely on the characteristics of the institutional framework.

### *4.2.3. Methodological issues and Limits*

#### 4.2.3.1. Accounting for integrated supply chains

Our indicator is based on the comparison of bargaining power scores between different levels. Our analysis relies on the key assumption that each level is independent from the other. This is not necessarily observed, as actors in agricultural supply chains often have a strategy entailing the vertical integration of different levels.

In a similar way, some supply chains may be entirely controlled by a single coop, as is the case, for instance, for the Zagora Apple PDO. Even though one cannot strictly speak of vertically integrated supply chains because farms are legally independent from the coop, this type of cases raises a specific issue in the sense that the vertical distribution of bargaining power would be dramatically influenced by the coop strategy (Filippi et al., 2008), which is not accounted for in our analysis.

Finally, our analysis falls short for "short food supply chains", which are based on the assumption of the existence of, at most, one intermediary between farmers and end-consumers (Aubry and Chiffoleau, 2009). But at the same time, some authors argued that this type of supply chain is more sustainable than longer ones regarding bargaining power distribution (Canfora, 2016). One can therefore confidently assume that this type of supply chain can be classified as "socially sustainable".

#### 4.2.3.2. The case of agricultural coops and producer organizations

Agricultural coops raise another specific issue in the analysis of the vertical distribution of bargaining power. Indeed, even though they are legally independent from the farms they are serving, their existence precisely lies in the fact that they aim at aggregating the individual production of their members and farmers are considered as involved in setting the coop's strategy (Filippi, 2014). Farmers' investment in coops is therefore aimed at restoring a balance in bargaining power with downstream levels, an objective that is also at stake in producers organizations. In order to account for this distortion with the supply chain model, we were led to count farmers groups belonging to coops or to producers organizations as one single entity.

## 4.3. Gender equality and age balance

The rationale for investigating age balance (i.e., generational change) and gender balance (i.e., gender equality) can be traced back to a development approach according to which, the existence of gender or age imbalances constitutes a penalty for one of the genders or some age classes. Sustainable development, and sustainability in general, should be about preserving or providing equal opportunities to all socio-demographic groups in society. Therefore, age balance and gender equality have been evaluated employing the following indicators:

- the Generational Change Indicator
- the Gender Equality Indicator

The Generational Change (GC) Indicator is calculated as the percentage ratio between the number of individuals in the 15-35 age bracket to the number of individuals in the 45-65 age range employed in each $j^{th}$ stage of both the supply chain of the FQS and Reference (REF) products. A simple expression of the GC indicator is:

$$GC_j(\%) = \frac{EMP_{15\div35;j}}{EMP_{45\div65;j}} \cdot 100$$

By construction, the indicator is unbounded in nature (i.e., it does not have a theoretical upper value) and the higher it is, the higher could be the number of employees in the 15 to 35 years of age range compared to the employees in the 45 to 65 years age range, at every $j^{th}$ stage of the supply chain of both the FQS and REF product supply chains. Values of the GC indicator lower than 100% could be deemed to endanger the possibility of carrying out vital activities to produce both products, therefore undermining the associated social sustainability. Hence, GC = 100% could be identified as a "natural" sustainability threshold. However, it should be acknowledged that values of the GC indicator much larger than 100% could represent a case of social unsustainability. Indeed, a very high value of the GC indicator could be determined by very few "experienced" workers being employed in the stage of the supply chain considered. In turn, the lack of experience and knowledge ensured by older employees may be though to undermine the social sustainability of the product as much as the lack of strength and stamina contributed by young employees. Nonetheless, because the GC indicator does not have a clear maximum value, it is difficult to identify a range of "optimal" values. Lastly, any positive difference in the values of the GC indicator across products would identify the more socially sustainable one, in a comparative analysis.

The formalisation of the Gender Equality (GE) Indicator draws on the methodology and – to some extent – data for the calculation of the UNDP Human Development Index (HDI), and its component Gender Inequality Indicator (GII) (UNDP, 2018). The indicator is based on the calculation of arithmetic and geometric means of gender-specific values of variables capable of capturing the empowerment and importance of either gender in the domains of interest of the researcher. In the realm of the S2F Project, we thought to investigate gender-specific variables for entrepreneurship (i.e., farm/firm/shop ownership, $E_{i,j}$), employment ($EMP_{i,j}$) and completed secondary-and-higher education of the workforce ($EMPSE_{i,j}$) at every $j^{th}$ stage of the supply chain. While these are the domains we deem of interest, pilot testing of the indicator has revealed that obtaining the variable $EMPSE_{i,j}$ has been difficult. Therefore, the calculation of the GE Indicator has relied on a "simplified" formulation accounting only for the role of $E_{i,j}$ and $EMP_{i,j}$. Because both formulations of the indicator require the calculation of geometric means, it is impossible to calculate the indicators whenever a 0% occurs. Therefore, following the indications in UNDP (2018), a minimum value of 0.1% (or 0.001) is employed instead. The calculating formulae for the GE indicators can be found in Deliverable 3.2, where we refer the interested reader for details. By construction, the GE Indicator is bounded in the interval [0;1], with higher values of the GE Indicating more equal opportunities across genders, in the relevant domains. In turn, this increases the social sustainability of the (stage of the) supply chain considered. While it may be difficult to identify a clear sustainability threshold for the GE Indicator, one could agree that 0.5 could be such a level. Positive differences in the value of the indicator across (stages of the) supply chains identify products with higher social sustainability.

The results of the calculation of the GC and GE indicators are reported below, depicting the values of the indicators calculated for farm and processing stages of the FQSs and REF products supply chains if suitable data were provided. Furthermore, the simple average across the stages of the same supply chain, gives rise to the supply-chain average value of the indicators.

#### *4.3.1. Generational change at farm level of the Supply Chains*

**Figure 25. FQS and REF values of the generational change indicator at farm level**

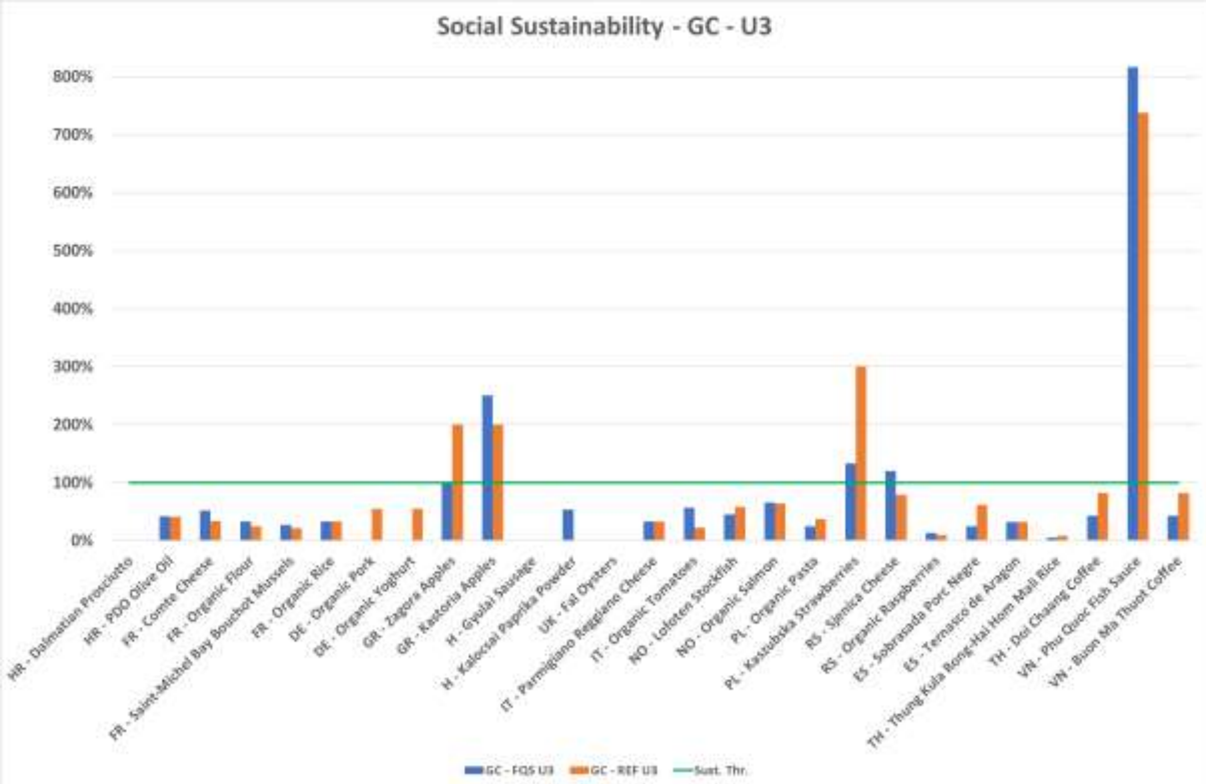



Figure 25 suggests that the picture of social sustainability at farm level is dominated by the results of the calculation of the GC Indicator for the Vietnamese Phu Quoc Fish Sauce, which displays almost an "outlier-type" behaviour, being largely incomparable to the results for any other case study. While only three countries feature case studies in which both FQS and REF products are socially sustainable in absolute terms, because both exceed the 100% threshold value of the GC Indicator (i.e., Greece, Poland and Vietnam), the Republic of Serbia Sjenica Cheese and the REF apple to the Zagora FQS are also socially sustainable, in absolute terms, according to the GC Indicator.

**Table 23. Summary of the results for the calculation of the generational change indicator at U3**

| | # of products | # of products GC>=100% | % of products GC>=100% | # cases | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|---|---|---|
| **GC - FQS U3** | 22 | 5 | 22.73% | 21 | 13 | 61.90% |
| **GC - REF U3** | 23 | 4 | 17.39% | | | |

Table 23 provides summary evidence of the very limited extent of "absolute" social sustainability, according to the GC Indicator, at farm level of the supply chains for both FQSs and REF products for which data was provided. Indeed, only in less than 23% of cases, "absolute" social sustainability is achieved at farm stage of the supply chain of FQS. However, even fewer REF products are socially sustainable, according to the GC Indicator, at farm level (17.39% of cases). In comparative terms, in almost 62% of the case studies for which the GC Indicator could be calculated for both the FQS and the REF product the former is more socially sustainable than the latter. The sustainability advantage pertaining to FQS appears rather small across cases, except for the French Comte Cheese, the Greek Kastoria Apple, the Italian Organic Tomatoes and the Republic of Serbia Sjenica Cheese.

Further insights can be obtained investigating whether FQSs are more sustainable than the associated case-studies reference products because of the type of product they represent (i.e., animal, vegetable or fish) or due to their certification (i.e., geographical indications (GIs) or organic).

**Table 24. Performance of FQS on generational change, by product type**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Animal** | 5 | 4 | 80.00% |
| **Vegetable** | 12 | 6 | 50.00% |
| **Fish** | 4 | 3 | 75.00% |

**Table 25 Performance of FQS on generational change, according to the certification**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Organic** | 6 | 5 | 83.33% |
| **GIs** | 15 | 8 | 53.33% |

Table 24 suggests that a higher social sustainability of FQSs is achieved very frequently indeed for animal and fish products, while in only half of the vegetable cases.

Table 25 informs about the extent of higher social sustainability of the FQSs, compared to the related reference products, distinguishing between Organic and GIs certifications. It appears that it occurs more frequently that the FQSs performs better in terms of social sustainability, according to the GC indicator, at farm in the case of the Organic certification, than in the case of GIs. This may be associated with the organic production system requiring more of the creativity, education and innovativeness of the young generations. The attractiveness of organic farming to young farmers confirms the findings of several previous studies (Koesling et al., 2008; Latruffe et al., 2013).

### *4.3.2. Generational change at processing level of the Supply Chains*

**Figure 26. FQS and REF values of the generational change indicator at processing level**

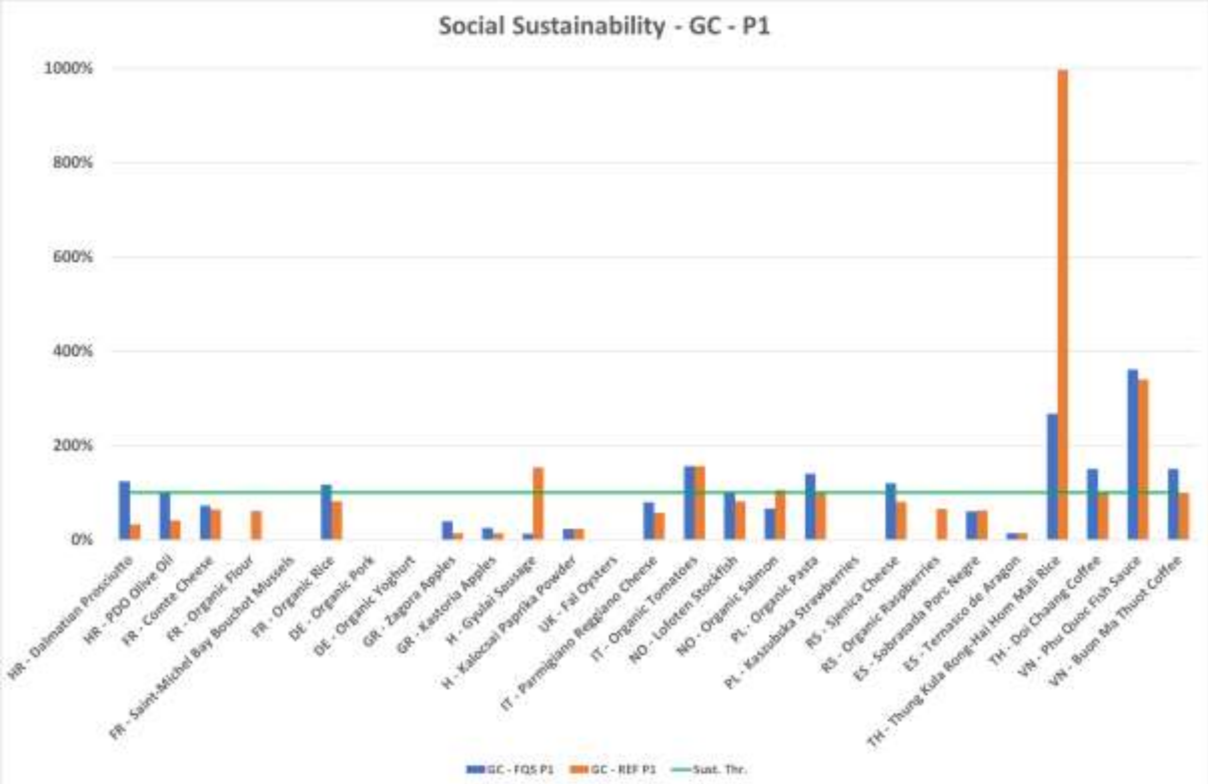



Figure 26 confirms that only few case studies are characterised by both the FQS and the reference products being sustainable, according to the GC indicator, at processing stage of the supply chains. Indeed, the Thai Thung Kula Rong-Hai Hom Mali Rice, the Vietnamese Phu Quoc Fish Sauce and the Italian Organic Tomatoes case studies feature values of the GC indicator larger than 100%. While the value of the GC indicator calculated for processing stage of the supply chain of the reference product to the Thai Thung Kula Rong-Hai Hom Mali Rice is worryingly higher than the values of the GC indicators calculated for the Vietnamese Phu Quoc Fish Sauce, there seem to be fewer large values of the GC indicator than at farm stage.

Moreover, compared to the results obtained for farm level of the supply chains, many more case studies could be deemed to achieve "absolute" social sustainability because of the product with the lower value of the GC records a value exactly equal to 100% (i.e., perfect generational change). Among them, we could list the Polish Organic Pasta and the Vietnamese Phu Quoc Fish Sauce. Furthermore, contrary to the evidence provided for farm level of the supply chains, it seems that social sustainability is achieved by many more FQSs and reference products at processing stage of the supply chain. In fact, considering also the data presented in Table 26 and comparing them with those in Table 23, it is easy to appreciate that the products' social sustainability at processing level is more than double the one at farm level.

**Table 26. Summary of the results of the calculation of the generational change indicator at processing level**

| | # of products | # of products GC>=100% | % of products GC>=100% | # cases | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|---|---|---|
| **GC - FQS P1** | 20 | 10 | 50.00% | 20 | 16 | 80.00% |
| **GC - REF P1** | 22 | 8 | 36.36% | | | |

The improvement in "absolute" sustainability along the products' supply chains (i.e., from farm to processing) is more sizeable than the improvement in the percentage of cases for which the FQS product has a higher social sustainability than the reference product.

Table 27 suggests that the higher social sustainability of FQSs, compared to the reference products, according to the GC indicator occurs for almost all case studies of vegetable products, while animal and fish cases feature a higher number of case studies for which the reference product is more sustainable than the FQS one. The higher level of social sustainability, according to the GC indicator, characterising the processing level of the supply chain, compared to the farm level, might be due to a significant part of the youth employment in food processing activities being temporary in nature. This may hold particularly true for the processing of vegetable products, which may employ students during the summer months. For instance, the larger than 100% value of the GC indicator for the Italian Organic Tomatoes case study can be due to working at a tomato processing factory being a favourite summer job of students. However, this may also reflect the economic attractiveness of producing a quality product, like in the case of the Vietnamese Phu Quoc Fish Sauce.

**Table 27. Performance of FQS on generational change, by product type**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Animal** | 7 | 5 | 71.43% |
| **Vegetable** | 10 | 9 | 90.00% |
| **Fish** | 3 | 2 | 66.67% |

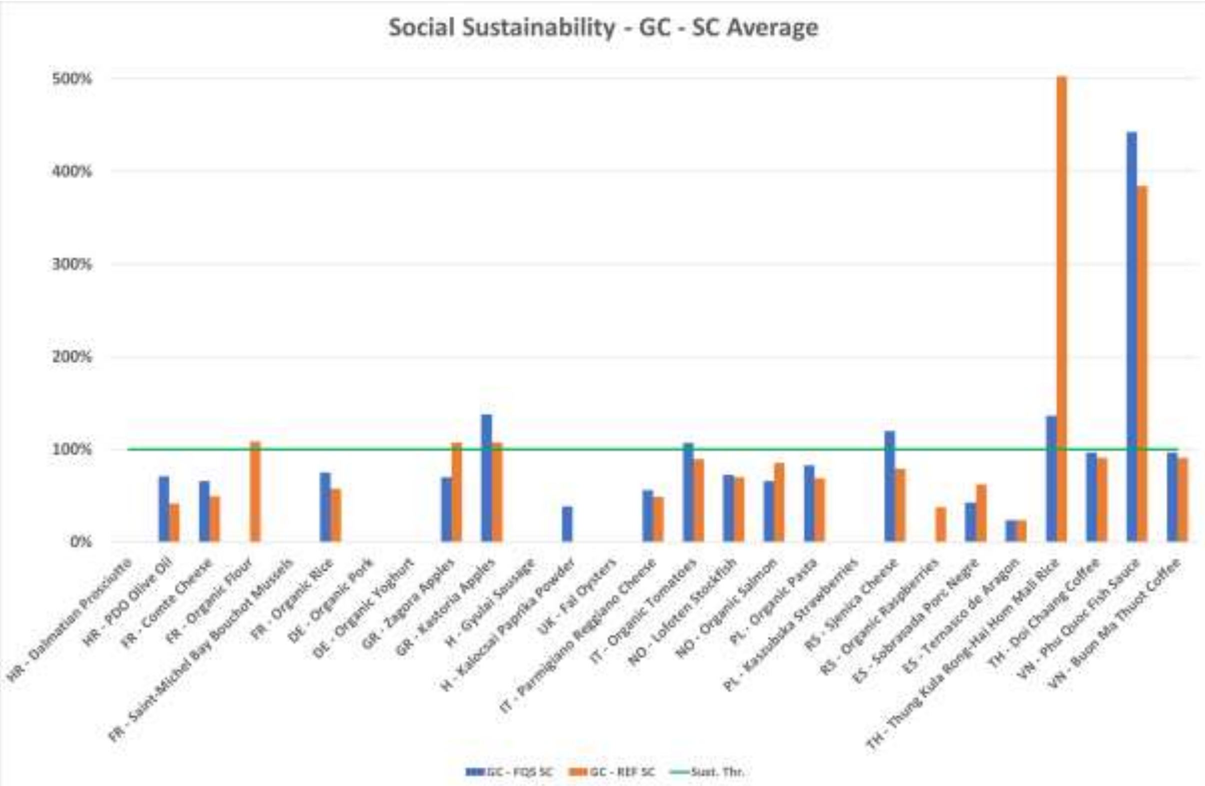
**Table 28. Performance of FQS on generational change, according to the certification**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Organic** | 4 | 3 | 75.00% |
| **GIs** | 16 | 13 | 81.25% |

Contrary to the evidence accumulated at farm stage of the supply chains, Table 28 informs that it is more frequent that FQS products are more sustainable than the reference ones, whenever quality is associated with a GI, rather than with the Organic certification. This evidence is particularly encouraging with respect to the possibility of continuing the production of GI products across generations. The youth contribution to this process may be related to the possibility of employing "traditional" GI products in the preparation of "new" food products, featuring the GI product as ingredient. Therefore, youngsters employed at processing stage of the supply chain may be the GIs' best opportunity to implement innovations, while maintaining the product's tradition.

### *4.3.3. Generational change at the SC level*

**Figure 27. FQS and REF values of the generational change indicator at the SC level**




Averaging the values of the GC indicator calculated at farm and processing levels provides the data to prepare Figure 27. The simple average of the values of the indicators at farm and processing levels reduces the incidence of the extreme values recorded for the Thai Thung Kula Rong-Hai Hom Mali Rice and the Vietnamese Phu Quoc Fish Sauce. The supply chains of both FQSs and reference products achieve social sustainability, according to the GC indicator, in Thailand for the Thung Kula Rong-Hai Hom Mali Rice case, in Vietnam for the Phu Quoc Fish Sauce case and in Greece for the Kastoria Apple. Likewise, in the Thai Doi Chaang Coffee and the Vietnamese Buon Ma Thuot Coffee case studies bot the supply chain of the FQS and reference products are almost socially sustainable in "absolute" terms.

According to Table 29, only five FQSs and reference products are socially sustainable, in absolute term, according to the values of the GC indicator. Italian Organic Tomatoes and the Republic of Serbia Sjenica Cheese are among the socially sustainable FQSs, while Conventional Flour and the Counterpart to the Zagora Apple belong to the socially sustainable Counterpart products.

**Table 29. Summary of the results for the calculation of the GC at the SC level**

| | # of products | # of products GC>=100% | % of products GC>=100% | # cases | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|---|---|---|
| **GC - FQS SC** | 18 | 5 | 27.78% | 17 | 13 | 76.47% |
| **GC -** REF **SC** | 19 | 5 | 26.32% | | | |

In comparative terms, more than ¾ of the case studies are characterised by the supply chain of a FQS product being more socially sustainable than the supply chain of its reference product, according to the GC indicator. This poses well for the possibility of maintaining the supply chains of FQSs viable over the generations, transmitting the production and processing knowledge of the experienced and older workers to the younger ones. Should this SC-level higher social sustainability of the FQSs be paired also with higher economic and/or environmental SC-level sustainability, FQSs may potentially emerge as the preferred production options, compared to the related reference products, for newly established/young processors settling/settled in the FQSs production areas and aiming for their productions being sustainable.

**Table 30. Performance of FQS on generational change, by product type**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Animal** | 5 | 4 | 80.00% |
| **Vegetable** | 9 | 7 | 77.78% |
| **Fish** | 3 | 2 | 66.67% |

Table 30 suggests that almost all the case studies for animal and fish products are socially sustainable, and only among the vegetable products, two seem to be socially unsustainable – compared to their reference products – at the whole SC-level. Because the number of cases analysed for each product category is very small, the interested reader may wish to focus its attention on the absolute number, rather than the percentage, of cases for which the FQS outperforms its reference product in terms of SC-level value of the GC indicator and, hence, social sustainability.

**Table 31. Performance of FQS on generational change, according to the certification**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Organic** | 4 | 3 | 75.00% |
| **GIs** | 13 | 10 | 76.92% |

Focusing on the count of sustainable cases, Table 31 indicates that only one organic case, compared to three GI ones, is unsustainable with respect to the SC-level values of the GC indicator. This evidence may corroborate the young workers' intention to get involved in productions certified Organic, rather than carrying a GI, possibly because the former is perceived more innovative and desirable to the (young) consumer on the market, than the latter.

### *4.3.4. Gender equality at farm level of the Supply Chains*

**Figure 28. FQS and REF values of the gender equality indicator at farm level**

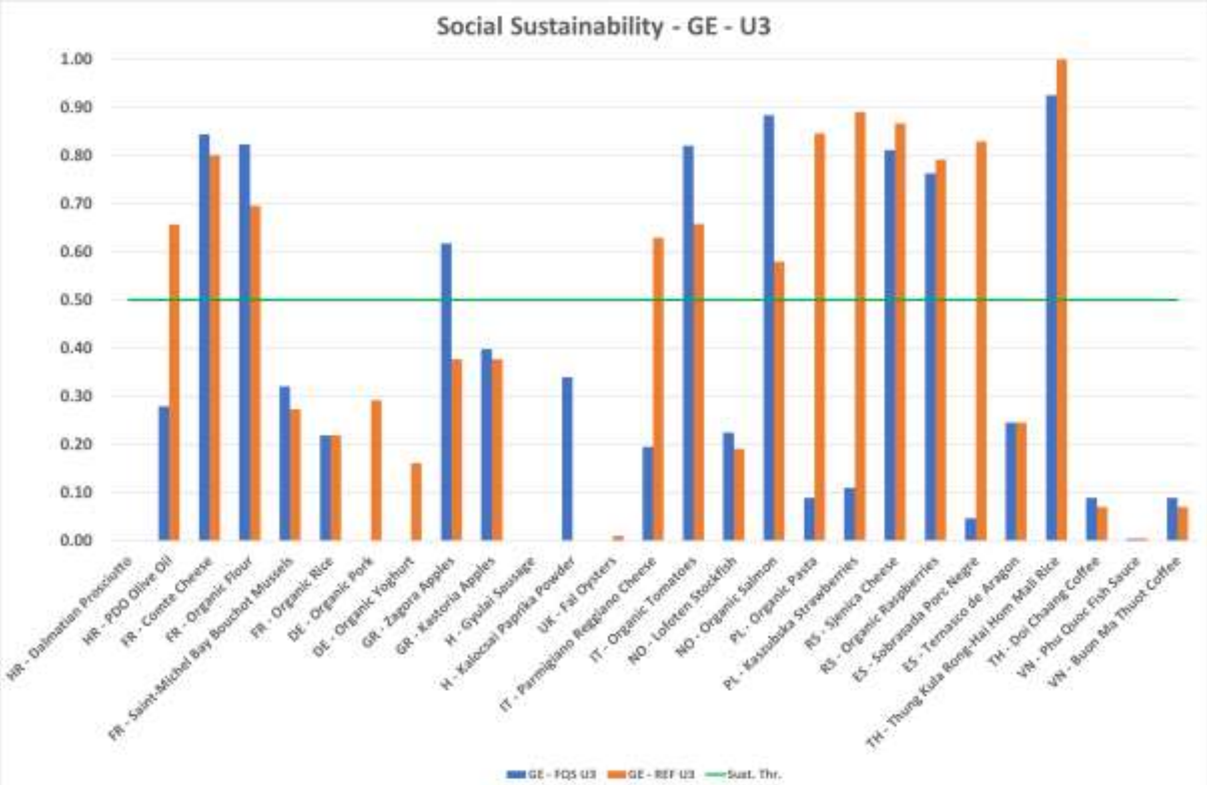



Figure 28 presents a graph of the values of the GE indicator, calculated for farm stage of the FQS and REF products investigated in the case studies carried out in the WP5 of the S2F project. Compared to the discussion provided for the calculations of the GC indicator, because the GE one is bounded in the interval [0;1], it is not clear whether any value calculated for the indicator could be deemed an outlier. While the reference product to the Thai Thung Kula Rong-Hai Hom Mali Rice appears characterised by perfect gender balance at farm stage, the Vietnamese case study for the Phu Quoc Fish Sauce seems to report an almost zero gender equality indicator. The other case featuring an almost zero value of the GE indicator is the United Kingdom Fal Oysters, for which the GI denomination is owned and employed by only one company, which is run by a male. Although farm stage of the supply chains in both case studies might require similar amounts of (high intensity) manual labour, such that one would expect more males being involved in breeding/agricultural operations than females (hence, reducing the extent of gender equality), the GE indicator remained very high indeed also for both the FQS and the REF product investigated in the Thai Thung Kula Rong-Hai Hom Mali Rice case study.

According to Table 32, more than a third of the products with a FQS certification considered in the case studies achieves “absolute” social sustainability, because the value of the GE indicator is larger than 0.5, “absolute” social sustainability, according to the value of the GE indicator, seems to characterise half of the REF products considered in the case studies. The higher percentage for REF products achieving social sustainability, according to the GE indicator, compared to FQSs one, may be due to the higher probability of employing females in non-certified productions, which may be demanded in higher quantities and which may rely on more industrialised/mechanised processes, than in certified ones. Examples of such case studies include the Croatian PDO Olive Oil, the Polish Organic Pasta and Kaszubska Strawberries, as well as the Spanish Sobrasada Porc Negre. This may be the case on the backdrop of the production of the agricultural/fishery outputs being a largely male-dominated industry, due to the demanding nature of physical labour required in daily operations, which often are carried out in harsh weather conditions.

**Table 32. Summary of the results of the calculation of the gender equality indicator at farm level**

| | # of products | # of products GE>=0.5 | % of products GE>=0.5 | # cases | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|---|---|---|
| **GE - FQS U3** | 23 | 8 | 34.78% | 22 | 12 | 54.55% |
| **GE - REF U3** | 24 | 12 | 50.00% | | | |

In comparative terms, in more than half of the case studies for which the GE indicator could be calculated for both the FQS and REF product, the former outperforms the latter in terms of social sustainability, as captured by the GE indicator. Therefore, FQSs seem to guarantee more equal employment opportunities, across genders, than the chosen REF products. As such, they should contribute to raising social sustainability and sustainable development, by removing/avoiding creating the sources of additional inequality.

**Table 33. Performance of FQS on gender equality, by product type**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Animal** | 5 | 2 | 40.00% |
| **Vegetable** | 12 | 7 | 58.33% |
| **Fish** | 5 | 3 | 60.00% |

Vegetable and fish products appear to be the categories characterised by higher social sustainability, compared to the animal ones, according to the GE indicator, as summarised in Table 33. The lower GE characterising animal productions, compared to the other two, may reflect the physical and demanding nature of the labour required to manage cows and pigs for many of the animal case studies considered in WP5.

**Table 34. Performance of FQS on gender equality, according to the certification**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Organic** | 6 | 4 | 66.67% |
| **GIs** | 16 | 8 | 50.00% |

The GE indicator, calculated at farm level, seems to confirm the evidence – already discussed – that Organic products appear to be more socially sustainable than GI products. Assuming agricultural/aquaculture primary activities are usually biased against female participation, this evidence could be consistent with the behavioural attitude that females are altruistic, and care for the health of others and of the environment. Therefore, it may not be surprising that females are more involved in producing Organic agricultural/aquaculture commodities than conventional ones for the supply chain of GIs.

### *4.3.5. Gender equality at the processing level of the Supply Chains*

**Figure 29. FQS and REF values of the gender equality indicator at processing level**

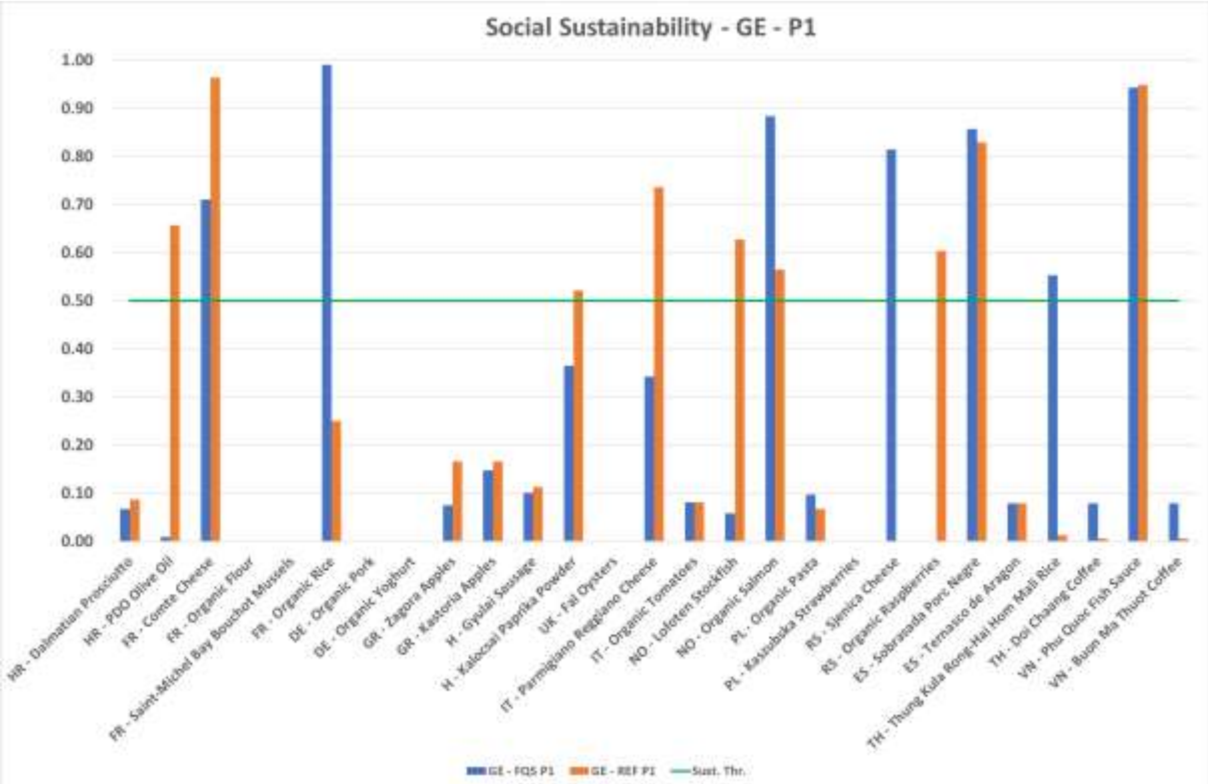



Figure 29 presents the results of the calculation of the GE indicator at processing level of the SCs of the FQS and REF products considered in the case studies carried out in WP5. Together with Table 35, it conveys that case study conductors seem to have struggled more to find the data for the variables required to calculate the GE indicator at processing level than at farm one. It appears that data sourcing has been particularly problematic for a few case studies centred around Organic products (i.e., the French Organic Flour; the German Organic Pork and Yogurt). However, it seems that many more products achieve a very high level of social sustainability, according to the GC indicator. In fact, four of all those investigated, record a GE indicator between 0.9 and 1.0. They include the REF product to the French Comte Cheese and Organic Rice and the Vietnamese Phu Quoc Fish Sauce and its reference product. Among them, the processing stage of the supply chain of the French Organic Rice seems to be characterised by an almost complete GE. A similarly high value of the GE indicator is calculated for the REF product to the Comte Cheese. The values of the GE indicator calculated for the supply chains of the FQS and REF products in the case studies centred around the Spanish Sobrasada Porc Negre and Vietnamese Phu Quoc Fish Sauce are very high and remarkably close to each other. Although the absolute value of the GE indicators is much smaller, for the Italian Organic Tomatoes and Spanish Ternasco de Aragon, once again, the value of the GE indicator for FQS and REF products are exactly equal to each other. This occurs because the processing plants for the Italian Organic Tomatoes, Spanish Ternasco de Aragon and Sobrasada Porc Negre produce both the FQS and REF products as two different product lines (i.e., separate specialised plants do not exist). The result for the Vietnamese Phu Quoc Fish Sauce arises because of a combination of the high profitability of the production of fish sauces, the small to medium-sized nature of the processing operations which has allowed firms to remain mainly family business and, lastly, the absence of major barriers to female entrepreneurship and employment. In fact, it is reported that both husband and wife are involved in running different aspects of the processing (retailing) of (Phu Quoc) Fish Sauce(s). Furthermore, female promenance in this sector can be gauged also from the fact that the President of Phu Quoc Fish Sauce Consortium is, indeed, a woman.

**Table 35. Summary of the results of the calculation of the gender equality indicator at processing level**

| | # of products | # of products GE>=0.5 | % of products GE>=0.5 | # cases | # cases FQS>REF | % cases FQS>REF |
|---|---|---|---|---|---|---|
| **GE - FQS** | 20 | 7 | 35.00% | 19 | 9 | 47.37% |
| **GE - REF** | 20 | 9 | 45.00% | | | |

Once again, Table 35 informs that social sustainability at processing level, according to the value of the GC indicator, is achieved - in absolute terms - more often by REF products than by FQS ones. In relative terms, only roughly half of the cases are characterised by FQSs being more socially sustainable, at processing level and according to the GE indicator, than the REF ones.

**Table 36. Performance of FQS on gender equality, by product type**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Animal** | 6 | 2 | 33.33% |
| **Vegetable** | 10 | 6 | 60.00% |
| **Fish** | 3 | 1 | 33.33% |

Vegetable case studies seem to consistently be the ones with the highest social sustainability, also according to the GC indicator calculated at processing stage presented in Table 36. Especially for the processing of large animal productions, like it is the case in the realm of the case studies carried out in WP5, the low GE could be signalling that women are excluded from having access to the dangerous and cold factory floor of medium to large scale slaughterhouses and meatpacking facilities. However, this penalty could be counterbalanced by the possibility that females own these operations.

**Table 37. Performance of FQS on gender equality, according to the certification**

| | # of cases (FQS and C available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Organic** | 4 | 4 | 100.00% |
| **GIs** | 15 | 5 | 33.33% |

It is somewhat surprising that Table 37 presents such opposite results. On the one hand, it confirms the result that products certified Organic are characterised by the processing stage of their supply chain being more socially sustainable than the one of their conventional references. On the other hand, it suggests that in only a third of the case studies centred around a GI certified product the FQS product is more socially sustainable than its reference.

#### *4.3.6. Gender equality at the Supply Chains level*

**Figure 30. FQS and REF values of the gender equality indicator at the SC level**

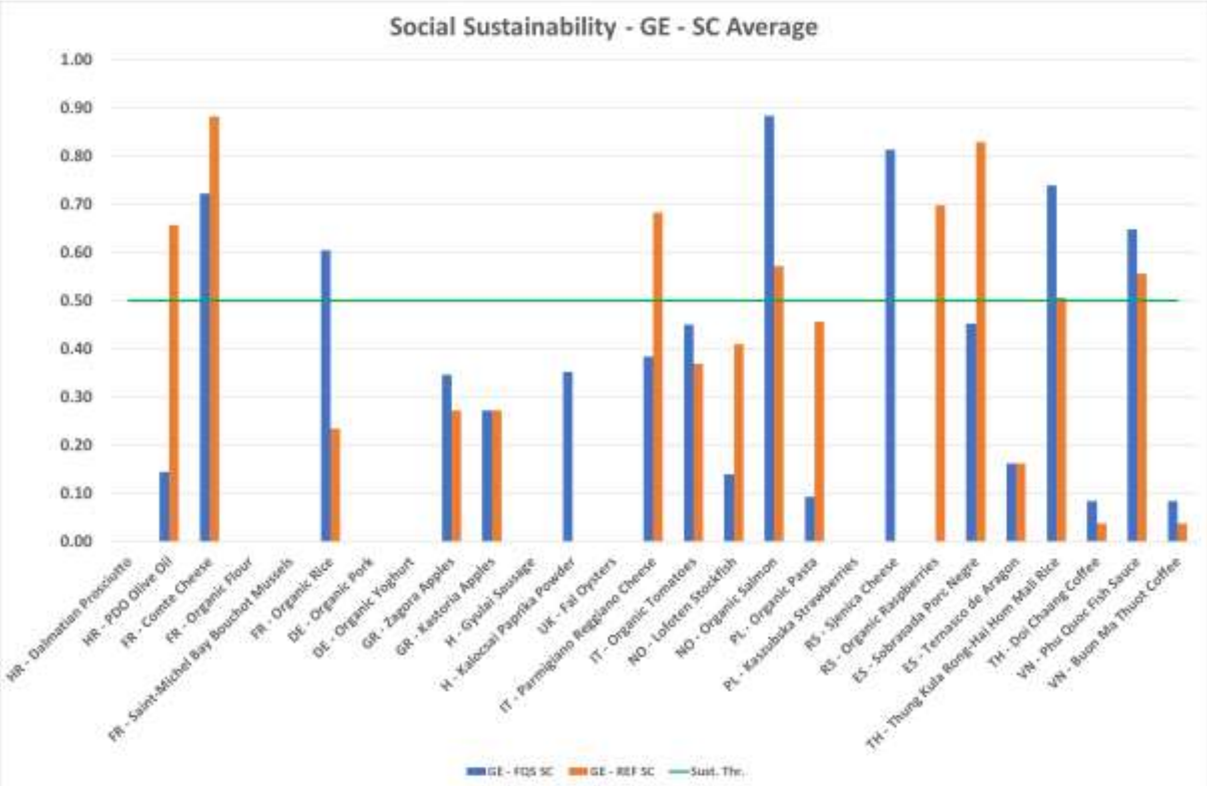



Figure 30 presents the evidence arising from averaging the results of the calculation of the GE indicator at farm and processing levels. No single product or case study achieves perfect GE. However, several products are socially sustainable, according to the GE indicator, in absolute term and at the SC level. In particular, they include: French Organic Rice, the Republic of Serbia Sjenica Cheese, the REF product to the Croatian PDO Olive Oil, the conventional Republic of Serbia Raspberries and the REF product to the Spanish Sobrasada Porc Negre. Furthermore, both the SCs for the FQS and REF products considered in the French Comtè Cheese, Norwegian Organic Salmon, Thai Thung Kula Rong-Hai Hom Mali Rice and

Vietnamese Phu Quoc Fish Sauce case studies achieve absolute social sustainability according to the GE indicator.

**Table 38. Summary of the results of the calculation of the gender equality indicator at the SC level**

| | # of products | # of products GE>=0.5 | % products GE>=0.5 | # cases | # cases FQS>REF | % cases FQS>REF |
|---|---|---|---|---|---|---|
| **GE - FQS SC** | 18 | 6 | 33.33% | 16 | 10 | 62.50% |
| **GE - REF SC** | 17 | 8 | 47.06% | | | |

The SCs of REF products appear to achieve "absolute" social sustainability, according to the value of the GE indicator, more often than the SCs of FQSs. However, Table 38 informs that in more than 60% of the case studies completed in WP5, the SCs for FQS products outperform their respective REF products in terms of the GE indicator. This is very valuable evidence, which corroborates further the pro-development role of FQSs, because they allow both genders to be involved in the whole supply chain of FQSs more frequently than the respective REF products.

**Table 39. Performance of FQS on gender equality, by product type**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Animal** | 4 | 1 | 25.00% |
| **Vegetable** | 9 | 7 | 77.78% |
| **Fish** | 3 | 2 | 66.67% |

Table 39 suggests that, despite having been able to calculate the GE indicator at the SC level for only a handful of cases, in 2/3 of the fish cases the GE for the FQS product is higher than the one for the REF product while in a quarter of the animal cases this occurs. Vegetables is the product category for which the social sustainability of the FQS products is higher than the one of the REF products in terms of the value of the GE indicator. This signals that, although FQSs perform better than REFs in many cases in terms of GE in education, employment and entrepreneurship, there seems to exist gender inequality in the SCs of the products, which – arguably – demand the most physical effort, even in harsh weather or difficult working conditions, both at the farm and processing level: i.e., animal and fish products. Vegetable SCs seem to be more capable of granting more favourable working conditions and other educational and employment opportunities, such that a value of the GE indicator for the FQS products higher than the one of the REF products is more frequent than for any other product category.

**Table 40. Performance of FQS on gender equality, according to the certification**

| | # of cases (FQS and REF available) | # cases FQS>=REF | % cases FQS>=REF |
|---|---|---|---|
| **Organic** | 4 | 3 | 75.00% |
| **GIs** | 12 | 7 | 58.33% |

Once again, results for the GE indicator at the SC level confirm the evidence, established at farm and processing stages of the SCs, that FQSs outperform REF products with respect to the value of GE indicator more often whenever the product is certified organic, compared to GIs. Once again, assuming that there exists a bias against women in the (especially early) stages of the SCs of agri-food products, it may be possible to justify the evidence in Table 40 to the altruistic female care for the environment and individual health which motivates more women to produce more organic than GI produce.

### 4.4. Summary

The calculation of the GC and GE indicators to assess two aspects of the social sustainability of FQSs and REF products, both in "absolute" and in comparative terms, considered in the realm of the case studies foreseen for the WP5 of the S2F project, has provided an unprecedented opportunity to build a cross-section of the values of the two indicators of interest for some 35 to 47 products and 16 to 22 cases in 13 countries, mostly in Europe.

The analysis of the results of the calculation of the GC and GE indicators has been carried out both for each level of the SCs for which data were provided and for the whole SC, by averaging the values of the single stages, to maximise the informative potential of the data. At times, the latter have proven to be very challenging to acquire, especially for all the levels of the supply chain of certain products. This may have occurred because the organisation of supply chain of the product relies on raw materials imported from abroad (i.e., the Hungarian cases of the Gyulai Sausage and the reference product in the Kalocsai Paprika Powder case study) or simply because suitable data sources are lacking (i.e., the German reference products in the Organic Pork and Yogurt cases). Otherwise, in a few cases the data have shown "outlier-type" behaviours either because they were collected from a handful of direct questionnaires with farms/firms which were too homogeneous (i.e., the Greek case studies of the Zagora and Kastoria apples) or because their very large/low values, in and of themselves (i.e., the Vietnamese Phu Quoc Fish Sauce or the Thai Thung Kula Rong-Hai Hom Mali Rice).

Although the formulation of the indicators is rather simple in nature and relies on the calculation of ratios, several arithmetic and geometric means, unusually large values of the indicators may arise from employing very small values of the input variables. In particular, the GE indicator cannot handle zero input values, because it employs geometric means. Hence, 0 values have been substituted with the very small figure 0.001, which allows for calculating the indicator, without skewing the information provided by the variable too much.

Looking at the results for the SC level, which are thought to be representative of the overall performance of the products, the calculation of the GC and GE indicators for both FQS and REF products suggests that the values of GC and GE indicators are larger for FQS than for REF products in 76.47% and 62.50% of the case studies for which the complete information was provided. This result suggests that the (vast) majority of the products with a FQS designation analysed in the case studies are more socially sustainable than the associated REF products. An additional interesting finding is that, the percentage of products for which the FQS outperforms the REF in terms of the value of the GC indicator is larger for products with a GI than for organic, while the opposite is true when the value of the GE indicator is considered. Overall, these findings confirm the suitability of GIs and Organic products for favouring the generational renewal and balance of gender opportunities in agri-food production, compared to products without either denomination of quality.

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## ANNEX 1. ECONOMIC, ENVIRONMENTAL AND SOCIAL SUSTAINABILITY PERFORMANCE OF FSQ PER FQS TYPE AND PER SECTOR

### Figure 31. Economic, environmental and social sustainability performance of PDOs

Most indicators are averaged between levels of the supply chain before being compared with the exception of environmental indicators. For environmental indicators, the value adding up the environmental impact down to the lower relevant level (mostly processing for carbon and water and retail for foodmiles) is retained.

| PDO | | | | | |
|---|---|---|---|---|---|
| Total number of cases with indicators | | | | 8 | |
| | | | | | |
| **Indicator name** | **Cases with indicator** | **Median difference** | **Min / Max difference** | **Share of cases with difference > 10%** | **Share of cases with difference > -10%** |
| Price | 7 / 8 | 62% | [20% - 362%] | 100% | 100% |
| Gross value-added | 6 / 8 | 18% | [-22% - 77%] | 67% | 83% |
| Share of value exported within Europe | 3 / 8 | 257% | [-93% - 366%] | 67% | 67% |
| Gross operating margin | 6 / 8 | 24% | [-34% - 161%] | 83% | 83% |
| Net result | 1 / 8 | 86% | [86% - 86%] | 100% | 100% |
| Share of value exported outside Europe | 3 / 8 | -82% | [-100% - 459%] | 33% | 33% |
| Share of volume exported within Europe | 6 / 8 | -62% | [-100% - 359%] | 33% | 33% |
| Share of volume exported outside Europe | 6 / 8 | 166% | [-100% - 799%] | 50% | 50% |
| Carbon footprint of product | 7 / 8 | 6% | [-84% - 45%] | 43% | 57% |
| Carbon footprint of area | 6 / 8 | 27% | [-25% - 39%] | 83% | 83% |
| Distance traveled | 7 / 8 | 59% | [-35% - 100%] | 71% | 86% |
| Carbon emissions related to the transportation stage | 7 / 8 | 15% | [-91% - 100%] | 57% | 86% |
| Green water footprint (net consumption of water) | 6 / 8 | -34% | [-159% - 55%] | 17% | 33% |
| Grey water footprint (water pollution) | 6 / 8 | 6% | [-24% - 63%] | 50% | 67% |
| Blue water footprint (gross consumption of water) | 5 / 8 | -24% | [-217547% - 57%] | 40% | 40% |
| Labour-to-production ratio | 7 / 8 | -6% | [-22% - 313%] | 43% | 57% |
| Turnover-to-labour ratio | 6 / 8 | 17% | [-19% - 147%] | 50% | 67% |
| Bargaining power distribution | 4 / 8 | 91% | [-150% - 100%] | 75% | 75% |
| Educational attainment | 7 / 8 | 1% | [-4% - 149%] | 43% | 100% |
| Wage level | 6 / 8 | 16% | [2% - 378%] | 50% | 100% |
| Generational change | 6 / 8 | 32% | [0% - 72%] | 83% | 100% |
| Gender equality | 6 / 8 | -6% | [-19% - 38%] | 17% | 67% |
| Gender equality index | 5 / 8 | -91% | [-303% - 14%] | 20% | 20% |

## Figure 32. Economic, environmental and social sustainability performance of PGIs

Most indicators are averaged between levels of the supply chain before being compared with the exception of environmental indicators. For environmental indicators, the value adding up the environmental impact down to the lower relevant level (mostly processing for carbon and water and retail for foodmiles) is retained.

| PGI | | | | | |
|---|---|---|---|---|---|
| Total number of cases with indicators | | | | 11 | |
| | | | | | |
| Indicator name | Cases with indicator | Median difference | Min / Max difference | Share of cases with difference > 10% | Share of cases with difference > -10% |
| Price | 10 / 11 | 61% | [15% - 123%] | 100% | 100% |
| Gross value-added | 8 / 11 | 3% | [-24% - 38%] | 38% | 75% |
| Share of value exported within Europe | 9 / 11 | -59% | [-100% - 510411%] | 33% | 44% |
| Gross operating margin | 8 / 11 | 35% | [-82% - 111%] | 63% | 75% |
| Net result | 3 / 11 | 117% | [-11% - 121%] | 67% | 67% |
| Share of value exported outside Europe | 9 / 11 | -75% | [-100% - 100%] | 22% | 33% |
| Share of volume exported within Europe | 9 / 11 | 0% | [-100% - 13588%] | 44% | 56% |
| Share of volume exported outside Europe | 9 / 11 | -74% | [-100% - 100%] | 33% | 44% |
| Carbon footprint of product | 10 / 11 | -13% | [-85% - 51%] | 30% | 30% |
| Carbon footprint of area | 9 / 11 | 22% | [-26% - 71%] | 56% | 89% |
| Distance traveled | 9 / 11 | 2% | [-270% - 64%] | 44% | 89% |
| Carbon emissions related to the transportation stage | 9 / 11 | 4% | [-270% - 62%] | 44% | 78% |
| Green water footprint (net consumption of water) | 8 / 11 | -3% | [-31% - 53%] | 38% | 63% |
| Grey water footprint (water pollution) | 8 / 11 | 19% | [-62% - 98%] | 50% | 63% |
| Blue water footprint (gross consumption of water) | 8 / 11 | 21% | [-72% - 95%] | 50% | 75% |
| Labour-to-production ratio | 10 / 11 | 29% | [-86% - 1536%] | 60% | 80% |
| Turnover-to-labour ratio | 10 / 11 | 8% | [-89% - 315%] | 50% | 60% |
| Bargaining power distribution | 4 / 11 | -57% | [-100% - 74%] | 25% | 25% |
| Educational attainment | 10 / 11 | -20% | [-75% - 176%] | 30% | 50% |
| Wage level | 10 / 11 | 22% | [-72% - 2673%] | 50% | 80% |
| Generational change | 10 / 11 | 0% | [-92% - 276%] | 30% | 60% |
| Gender equality | 10 / 11 | 0% | [-709% - 14%] | 10% | 70% |
| Gender equality index | 9 / 11 | -2% | [-221% - 5%] | 0% | 56% |

## Figure 33. Economic, environmental and social sustainability performance of organic products

Most indicators are averaged between levels of the supply chain before being compared with the exception of environmental indicators. For environmental indicators, the value adding up the environmental impact down to the lower relevant level (mostly processing for carbon and water and retail for foodmiles) is retained.

| Organic | | | | | |
|---|---|---|---|---|---|
| Total number of cases with indicators | | | | 8 | |
| | | | | | |
| **Indicator name** | **Cases with indicator** | **Median difference** | **Min / Max difference** | **Share of cases with difference > 10%** | **Share of cases with difference > -10%** |
| Price | 8 / 8 | 73% | [16% - 291%] | 100% | 100% |
| Gross value-added | 8 / 8 | 16% | [-250% - 113%] | 63% | 88% |
| Share of value exported within Europe | 3 / 8 | -86% | [-100% - 0%] | 0% | 33% |
| Gross operating margin | 8 / 8 | 36% | [5% - 268%] | 88% | 100% |
| Net result | 3 / 8 | 189% | [7% - 447%] | 67% | 100% |
| Share of value exported outside Europe | 2 / 8 | -50% | [-100% - 0%] | 0% | 50% |
| Share of volume exported within Europe | 7 / 8 | -20% | [-100% - 91%] | 29% | 43% |
| Share of volume exported outside Europe | 5 / 8 | -94% | [-100% - 0%] | 0% | 20% |
| Carbon footprint of product | 8 / 8 | 11% | [-18% - 34%] | 50% | 88% |
| Carbon footprint of area | 8 / 8 | 37% | [25% - 65%] | 100% | 100% |
| Distance traveled | 8 / 8 | 20% | [2% - 100%] | 88% | 100% |
| Carbon emissions related to the transportation stage | 8 / 8 | 15% | [-15% - 100%] | 50% | 88% |
| Green water footprint (net consumption of water) | 7 / 8 | -74% | [-111% - -13%] | 0% | 0% |
| Grey water footprint (water pollution) | 7 / 8 | 3% | [-118% - 57%] | 29% | 57% |
| Blue water footprint (gross consumption of water) | 7 / 8 | 54% | [-18% - 93%] | 71% | 71% |
| Labour-to-production ratio | 8 / 8 | 22% | [-45% - 467%] | 75% | 75% |
| Turnover-to-labour ratio | 8 / 8 | 35% | [-10% - 161%] | 63% | 88% |
| Bargaining power distribution | 7 / 8 | 56% | [0% - 97%] | 86% | 100% |
| Educational attainment | 6 / 8 | 5% | [-10% - 76%] | 17% | 100% |
| Wage level | 6 / 8 | 70% | [24% - 141%] | 100% | 100% |
| Generational change | 6 / 8 | 26% | [-18% - 80%] | 67% | 83% |
| Gender equality | 6 / 8 | 0% | [-252% - 10%] | 0% | 83% |
| Gender equality index | 5 / 8 | 40% | [-14% - 99%] | 80% | 80% |

**Figure 34. Economic, environmental and social sustainability performance of vegetal products**

Most indicators are averaged between levels of the supply chain before being compared with the exception of environmental indicators. For environmental indicators, the value adding up the environmental impact down to the lower relevant level (mostly processing for carbon and water and retail for foodmiles) is retained.

| Vegetal | | | | | |
|---|---|---|---|---|---|
| Total number of cases with indicators | | | | 14 | |
| | | | | | |
| **Indicator name** | **Cases with indicator** | **Median difference** | **Min / Max difference** | **Share of cases with difference > 10%** | **Share of cases with difference > -10%** |
| Price | 13 / 14 | 74% | [16% - 362%] | 100% | 100% |
| Gross value-added | 11 / 14 | 22% | [0% - 113%] | 82% | 100% |
| Share of value exported within Europe | 5 / 14 | -88% | [-100% - 366%] | 20% | 40% |
| Gross operating margin | 11 / 14 | 57% | [5% - 161%] | 91% | 100% |
| Net result | 4 / 14 | 153% | [7% - 447%] | 75% | 100% |
| Share of value exported outside Europe | 6 / 14 | -41% | [-100% - 459%] | 33% | 50% |
| Share of volume exported within Europe | 10 / 14 | -48% | [-100% - 359%] | 30% | 40% |
| Share of volume exported outside Europe | 9 / 14 | -76% | [-100% - 359%] | 22% | 33% |
| Carbon footprint of product | 13 / 14 | 16% | [-84% - 51%] | 54% | 69% |
| Carbon footprint of area | 13 / 14 | 31% | [-26% - 65%] | 77% | 85% |
| Distance traveled | 12 / 14 | 45% | [2% - 100%] | 92% | 100% |
| Carbon emissions related to the transportation stage | 12 / 14 | 22% | [-15% - 100%] | 67% | 92% |
| Green water footprint (net consumption of water) | 12 / 14 | -27% | [-159% - 55%] | 17% | 17% |
| Grey water footprint (water pollution) | 12 / 14 | 9% | [-112% - 98%] | 50% | 58% |
| Blue water footprint (gross consumption of water) | 11 / 14 | 14% | [-217547% - 95%] | 55% | 55% |
| Labour-to-production ratio | 13 / 14 | -1% | [-45% - 478%] | 38% | 54% |
| Turnover-to-labour ratio | 12 / 14 | 35% | [-19% - 315%] | 67% | 83% |
| Bargaining power distribution | 7 / 14 | 13% | [-150% - 97%] | 57% | 71% |
| Educational attainment | 13 / 14 | 9% | [-48% - 176%] | 46% | 92% |
| Wage level | 11 / 14 | 63% | [2% - 2673%] | 73% | 100% |
| Generational change | 12 / 14 | 26% | [-56% - 80%] | 58% | 83% |
| Gender equality | 12 / 14 | 0% | [-709% - 38%] | 17% | 67% |
| Gender equality index | 10 / 14 | 3% | [-151% - 99%] | 40% | 60% |

## Figure 35. Economic, environmental and social sustainability performance of animal products

Most indicators are averaged between levels of the supply chain before being compared with the exception of environmental indicators. For environmental indicators, the value adding up the environmental impact down to the lower relevant level (mostly processing for carbon and water and retail for foodmiles) is retained.

| Animal | | | | | |
|---|---|---|---|---|---|
| Total number of cases with indicators | | | | 10 | |
| | | | | | |
| **Indicator name** | **Cases with indicator** | **Median difference** | **Min / Max difference** | **Share of cases with difference > 10%** | **Share of cases with difference > -10%** |
| Price | 10 / 10 | 61% | [15% - 125%] | 100% | 100% |
| Gross value-added | 9 / 10 | -2% | [-250% - 50%] | 33% | 56% |
| Share of value exported within Europe | 9 / 10 | -59% | [-100% - 510411%] | 33% | 44% |
| Gross operating margin | 9 / 10 | 22% | [-82% - 268%] | 67% | 67% |
| Net result | 2 / 10 | 104% | [86% - 121%] | 100% | 100% |
| Share of value exported outside Europe | 7 / 10 | -75% | [-100% - 100%] | 14% | 29% |
| Share of volume exported within Europe | 10 / 10 | -21% | [-100% - 13588%] | 40% | 50% |
| Share of volume exported outside Europe | 9 / 10 | -27% | [-100% - 799%] | 33% | 44% |
| Carbon footprint of product | 10 / 10 | -15% | [-85% - 15%] | 20% | 30% |
| Carbon footprint of area | 10 / 10 | 27% | [2% - 71%] | 80% | 100% |
| Distance traveled | 10 / 10 | 0% | [-270% - 100%] | 40% | 80% |
| Carbon emissions related to the transportation stage | 10 / 10 | 7% | [-270% - 100%] | 40% | 80% |
| Green water footprint (net consumption of water) | 9 / 10 | -8% | [-74% - 53%] | 22% | 56% |
| Grey water footprint (water pollution) | 9 / 10 | 2% | [-118% - 78%] | 33% | 67% |
| Blue water footprint (gross consumption of water) | 9 / 10 | 16% | [-26% - 90%] | 56% | 78% |
| Labour-to-production ratio | 10 / 10 | 34% | [-86% - 1536%] | 80% | 90% |
| Turnover-to-labour ratio | 10 / 10 | 6% | [-89% - 161%] | 40% | 60% |
| Bargaining power distribution | 7 / 10 | 74% | [-96% - 100%] | 71% | 71% |
| Educational attainment | 8 / 10 | -2% | [-75% - 1%] | 0% | 63% |
| Wage level | 9 / 10 | 23% | [-72% - 378%] | 56% | 78% |
| Generational change | 8 / 10 | 7% | [-92% - 276%] | 50% | 63% |
| Gender equality | 8 / 10 | -1% | [-15% - 10%] | 0% | 88% |
| Gender equality index | 8 / 10 | -24% | [-303% - 72%] | 13% | 50% |

### Figure 36. Economic, environmental and social sustainability performance of unfed seafood and fish products

Most indicators are averaged between levels of the supply chain before being compared with the exception of environmental indicators. For environmental indicators, the value adding up the environmental impact down to the lower relevant level (mostly processing for carbon and water and retail for foodmiles) is retained.

| Indicator name | Cases with indicator | Median difference | Min / Max difference | Share of cases with difference > 10% | Share of cases with difference > -10% |
|---|---|---|---|---|---|
| Price | 2 / 3 | 72% | [20% ; 123%] | 100% | 100% |
| Gross value-added | 2 / 3 | -1% | [-5% ; 3%] | 0% | 100% |
| Share of value exported within Europe | 1 / 3 | 58% | [58% ; 58%] | 100% | 100% |
| Gross operating margin | 2 / 3 | 7% | [-2% ; 16%] | 50% | 100% |
| Net result | 1 / 3 | -11% | [-11% ; -11%] | 0% | 0% |
| Share of value exported outside Europe | 1 / 3 | -80% | [-80% ; -80%] | 0% | 0% |
| Share of volume exported within Europe | 2 / 3 | 3% | [-81% ; 87%] | 50% | 50% |
| Share of volume exported outside Europe | 2 / 3 | 268% | [-79% ; 614%] | 50% | 50% |
| Carbon footprint of product | 2 / 3 | 27% | [6% ; 48%] | 50% | 100% |
| Carbon footprint of area | | | not applicable | | |
| Distance traveled | 2 / 3 | 11% | [2% ; 20%] | 50% | 100% |
| Carbon emissions related to the transportation stage | 2 / 3 | -20% | [-37% ; -3%] | 0% | 50% |
| Green water footprint (total water consumption) | | | not applicable | | |
| Grey water footprint (water pollution) | | | not applicable | | |
| Blue water footprint (surface and ground water consumption) | | | not applicable | | |
| Labour-to-production ratio | 2 / 3 | 18% | [16% ; 19%] | 100% | 100% |
| Turnover-to-labour ratio | 2 / 3 | 82% | [-11% ; 175%] | 50% | 50% |
| Bargaining power distribution | 1 / 3 | 100% | [100% ; 100%] | 100% | 100% |
| Educational attainment | 2 / 3 | -16% | [-44% ; 12%] | 50% | 50% |
| Wage level | 2 / 3 | 20% | [4% ; 35%] | 50% | 100% |
| Generational change | 2 / 3 | 16% | [0% ; 31%] | 50% | 100% |
| Gender equality | 2 / 3 | -5% | [-17% ; 7%] | 0% | 50% |
| Gender equality index | 1 / 3 | -77% | [-77% ; -77%] | 0% | 0% |

**The Strength2Food project in a nutshell**

Strength2Food is a five-year, €6.9 million project to improve the effectiveness of EU food quality schemes (FQS), public sector food procurement (PSFP) and to stimulate Short Food Supply Chains (SFSC) through research, innovation and demonstration activities. The 30-partner consortium representing 11 EU and four non-EU countries combines academic, communication, SMEs and stakeholder organisations to ensure a multi-actor approach. It will undertake case study-based quantitative research to measure economic, environmental and social impacts of FQS, PSFP and SFSC. The impact of PSFP policies on nutrition in school meals will also be assessed. Primary research will be complemented by econometric analysis of existing datasets to determine impacts of FQS and SFSC participation on farm performance, as well as understand price transmission and trade patterns. Consumer knowledge, confidence in, valuation and use of FQS labels and products will be assessed via survey, ethnographic and virtual supermarket-based research. Lessons from the research will be applied and verified in 6 pilot initiatives which bring together academic and non-academic partners. Impact will be maximised through a knowledge exchange platform, hybrid forums, educational resources and a Massive Open Online Course.

**www.strength2food.eu**