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The world is facing a looming biodiversity, climate and food security crisis (Hertel, 2011; Tilman et al., 2011; Wheeler and von Braun, 2013). Critical to meeting these challenges is the sustainable adaption of food production systems. Organic agriculture has been outlined as one key component of the overall solution as it is able to mitigate some of the negative externalities resulting from intensive agricultural practices (Fuller et al., 2005; Stolze and Lampkin, 2009; Lee et al., 2015; Squalli and Adamkiewicz, 2018; Pe'er et al., 2020; Müller et al., 2017). Organic agriculture is explicitly orientated towards sustainable food production via the maximisation of biodiversity, soil fertility and food quality (EU, 2018; Gomiero et al., 2011; IFOAM, 2008). These aims are achieved through the implementation of agroecological management practices that have been linked with advantages over conventional agriculture that include; lower environmental impacts, greater soil carbon capture and improved profitability (Cisilino et al., 2019; Gabriel et al., 2013; Scialabba and Müller-Lindenlauf, 2010; Smith et al., 2019; Tuck et al., 2014; Tuomisto et al., 2012). There has been a large policy focus on promoting organic agriculture in the EU over the last 30 years (Stolze and Lampkin, 2009), which has contributed to a higher area share compared to the global average (~8.5% versus ~1.5% (EC, 2021; Willer et al., 2021)). Nevertheless, the sector still requires significant growth given the ambitious target for 25% of the farmed area to be managed organically by 2030 through the Farm-to-Fork strategy (EC, 2021; Montanarella and Panagos, 2020; Moschitz et al., 2021).

While governments across Europe commit to organic targets, the extent to which past organic policies have had an impact on organic conversion at the country scale has been largely unexplored empirically. If the full benefits of organic agriculture are to be brought to fruition and targets are to be met, it is critical to develop insights into how organic policy can be formulated to efficiently and effectively drive its proliferation. National and EU-wide action plans are a frequently used policy intervention both within and outside of the agri-environmental setting. Organic action plans specifically aim to strengthen the organic sector in the EU, both on the demand and supply-side. Whilst demand-side effects have been studied (e.g. Sørensen et al., 2016; Lindström et al., 2020), supply-side effects of these action plans on organic farmed area are largely not verified empirically.

We here contribute to fill this gap and analyse the effectiveness of four national organic action plans (France, Sweden, Czech Republic and Austria) at stimulating organic farmland expansion. To this end, we use a balanced panel country-level dataset consisting of 26 OECD states between 2001 and 2019 (N = 494), and use the synthetic control method to quantify the treatment effects for the selected action plans on the respective organic farmland area following the methodology pioneered by (Abadie et al., 2015, 2010; Abadie and Gardeazabal, 2003).

Whilst a large number of studies have looked at drivers of organic agriculture adoption at the farm level (e.g. Allaire et al., 2015; Khaledi et al., 2010; Läpple and Kelley, 2013; Läpple and Rensburg, 2011; Malá and Malý, 2013; Musshoff and Hirschauer, 2008; Mzoughi, 2011; Pietola and Lansink, 2001; Schmidtner et al., 2012; Serebrennikov et al., 2020), setting the scope at this juncture limits the ability to quantify the effectiveness of any particular country scale policy intervention. Furthermore, the relatively more abundant qualitative and descriptive research efforts that investigated organic policies at a country level, such as organic action plans (Jahrl et al., 2016; Sanders, 2013; Sanders et al., 2011), are also limited in their ability to precisely measure the effect of a particular policy on the organic sector. To complement the existing literature, rigorous counterfactual analysis is needed, hence the approach adopted in this study. Previous studies clearly show that quantitative econometric research into understanding the effects of policy on organic adoption at a country level is generally underdeveloped (Daugbjerg et al., 2011; Lindström et al., 2020 being amoung the most recent examples).

This study seeks to make a novel contribution to the organic policy discourse through the assessment of the conversion effects of four selected national organic action plans implemented in four EU member states between 2001 and 2019. We apply the Synthetic Control Method to model conversion impacts, an econometric approach that has been described as one of the most important breakthroughs in policy evaluations within the last two decades (Athey and Imbens, 2017; Ferman et al., 2020). The method is especially relevant for our analysis as it enables the quantification of the effect of organic action plans by predicting the counterfactual year-on-year development of organic area using a weighted combination of untreated units – from a sample of multiple units known as the donor pool – to manufacture a single control unit. We use a donor pool of 26 OECD member states[1] with which to estimate the counterfactual.

Through this analysis, we find mixed results that indicate that the success of organic action plans is highly context specific. For instance, our analysis provides robust evidence of large, positive organic area increases resulting from the implementation of plans in France and Sweden (Figure 1) of 68 and 75 percentage points respectively (Table 1). The models indicated that these growth predictions were highly significant In real terms, this means that the additional organic farmland area attributed to the organic action plans equated to 397 thousand ha for France and 169 thousand ha

1 - The 26 countries included in the donor pool were Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Ireland, Latvia, Lithuania, the Netherlands, New Zealand, Norway, Poland, Slovakia, Slovenia, Spain, South Korea, Sweden, Switzerland and the UK.

for Sweden. The results were robust through a variety of robustness tests that included; Leave-out-one and in-space placebo tests as well as rigorous testing of different model specifications and donor pool sizes.

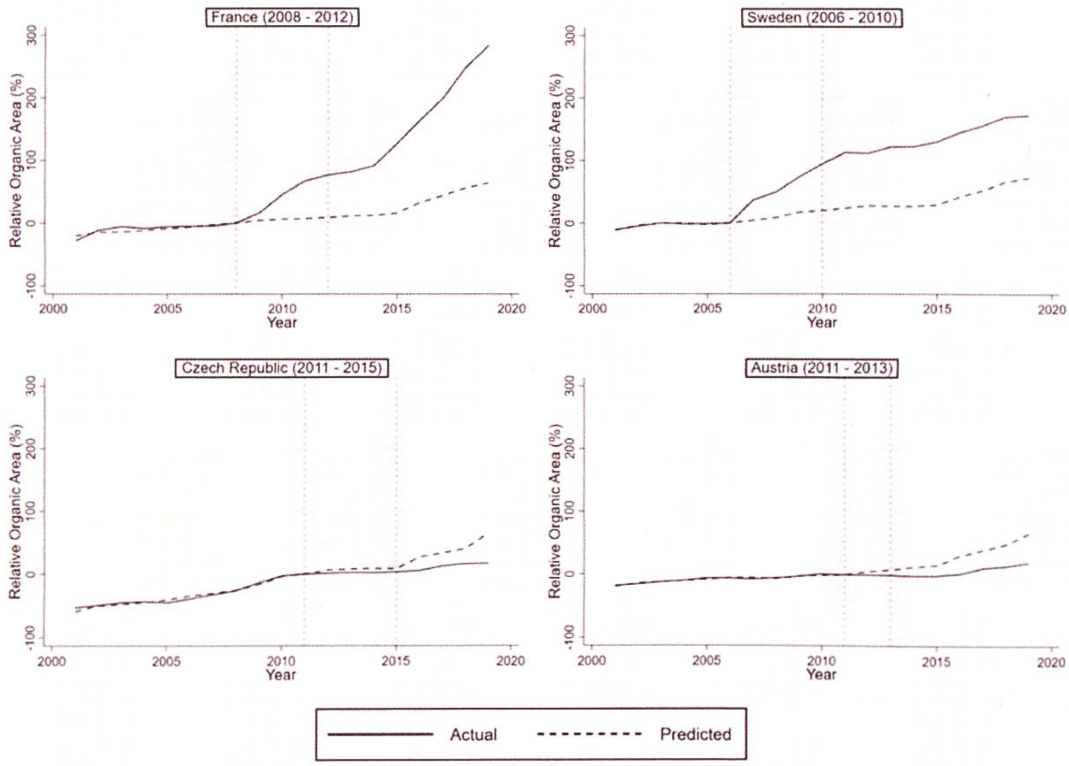

Figure 1. Predicted versus actual organic area growth trends post intervention via national organic action plan. The difference between the actual and predicted trends is termed the treatment effect. Please consult Table 1 for a quantification of these predicted treatment effects per country.

However, the Austrian and Czech plans are found to be ineffectual at stimulating growth (Figure 1), with both treatment effect predictions being insignificant. In the Austrian case, a no-treatment effect, makes reasonable sense seeing as the 2011 action plan was preceded by several similar action plans (not the case in France or Sweden). This could logically result in a stagnation of growth. In the Czech case, the apparent success of their first action plan starting in 2004 is likely highly correlated with their entry into the EU (also in 2004), and our results show that this effect had worn off by the second plan in 2011. Prior to the implementation of both the Czech and Austrian action plans, these countries already had relatively high shares of organic farmland compared to the EU average (also not the case in France and Sweden). The starting organic farmland area shares were 13.8% and 19.7% for the Czech Republic and Austria respectively. This is much lower than the shares for France and Sweden which were 2.0% and 7.2% respectively. Potentially, the lack of effect estimated by the models also indicates that the extent of organic area had already reached a critical point beyond which the imposition of an organic action plan could not conceivably result in increased farm-level adoption of organic agriculture in the Czech Republic and Austria. Whereas there was perhaps still latent capacity for organic area growth that could be initiated effectively by an action plan in France and Sweden. Additionally, the targets were much less ambitious in the Czech and Austrian plans relative to those of France and Sweden. These results also are likely an indication of decreasing marginal returns to action plans, whereby the repetition of plans, combined with higher organic farmland shares becomes increasingly less effective at delivering further organic farmland area growth.

Table 1. Treatment effect predictions quantifying the difference between the observed and the predicted growth estimations for organic area following the implementation of the action plans by the separate synthetic control models of the four case studies. Values are relative changes.

Country	Evaluated Period	Actual Growth	Counterfactual Growth	Calculated Treatment Effect
France	2008 to 2012	177 %	109 %	68 %-points
Sweden	2006 to 2010	195 %	120 %	75 %-points
Czech Republic	2011 to 2015	104 %	109 %	-5 %-points
Austria	2011 to 2013	99 %	108 %	-9 %-points

Actual growth is the percentage difference between the organic area at the end of the evaluated period relative to the organic area at the start of the organic action plan, if the area remained the same over that period the value of this would be 100. The counterfactual growth is the trend growth that is predicted by the synthetic control for the particular case assuming no treatment. The calculated treatment effect is thus the percentage point difference between the actual growth and the counterfactual growth, i.e. the difference between the observed and predicted organic farmland areas. This percentage point difference therefore represents the share of the growth that is directly attributable to the organic action plan given our stated assumptions and in lieu of tests of significance.

This thesis generates several key indications for policymakers. Firstly, the results support the argument that organic action plans can be effective at delivering growth, but they can also be confounded by other factors. This implies that the success of action plans can be inhibited through extenuating factors inherent in the planning, targeting and/or implementation phases of the plans. Nevertheless, it remains a realistic proposition that the initiation of a credible and financially backed organic action plan in a country where no such plan has yet been implemented is likely to positively affect the development of the organic industry in that country, particularly if organic uptake is low versus potential. Inter-governmental collaboration should be encouraged to this effect. Secondly, organic action plans may be subject to decreasing marginal returns and success could be dependent on the existing degree of organic coverage within the agricultural sector. This could signify that successive EU organic action plans based on similar sets of interventions may have a reduced leverage ability for the scaling of organic agriculture. Therefore, more wide-reaching incentives for adoption by farmers and for changes in consumer behaviour may be required to meet the 25% target of farmland area to be farmed organically by 2030.

Our analysis also has implications for further research. It would be pertinent here to re-emphasise that the effectiveness of organic action plans is clearly very context-specific. The performance will be highly related to the contents, targets, financial means and political backing underpinning the plan. Thus, additional studies and systematic assessments of policies to foster organic agriculture are needed to improve our understanding of exactly which type of interventions are most promising. Moreover, future research shall strive to assess a wider range of success measures, i.e. go beyond the share of organic farming. Finally, future research shall address the heterogenous nature of action plans and their effects by using a combination of qualitative and quantitative methods.

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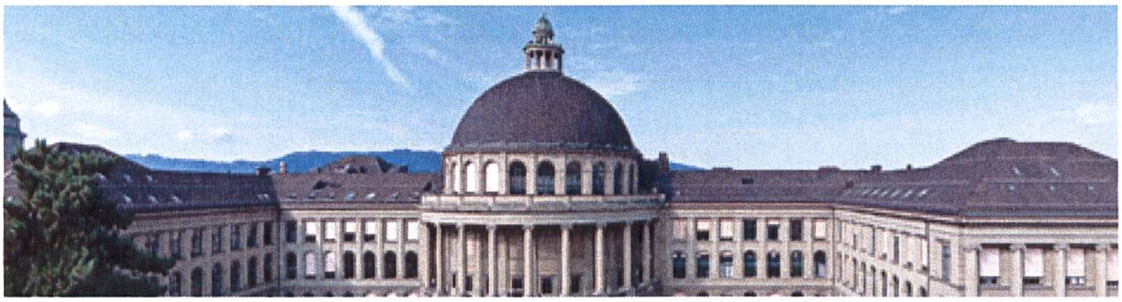

Source: ETH

The cost of climate change mitigation on Swiss farms

Calculating marginal abatement costs considering dairy farms' heterogeneity and measures interactions

Introduction

The agricultural sector must mitigate its greenhouse gas emissions if the Paris Agreement targets are to be met (Clark et al., 2020; Rosenzweig et al., 2020; Wollenberg et al., 2016). Knowing the cost-efficiency of mitigation measures is key to supporting effective policymaking. Bottom-up marginal abatement cost curves (MACC) are a widespread approach to inform policymakers about the cost-efficiency and the potential of mitigation measures in the agricultural sector. MACCs order measures by increasing marginal abatement costs (or decreasing cost-efficiency). The mitigation measures are depicted as a bar, whose width indicates the abatement potential, and the height corresponds to the marginal abetment cost. This allows for identifying the most cost-efficient mitigation measures for a given greenhouse gas emission reduction target. However, a key challenge in interpreting these MACCs is that farms may have different marginal abatement costs due to their structural characteristics. This heterogeneity e.g., between large and small farms, is usually not captured in MACCs of the agricultural sector as they consider average marginal abatement costs among farmers.

In addition, implementing different mitigation measures on a farm might lead to interactions between these measures. The interactions account for the changes in marginal abatement costs when measures are applied in combination instead of independently (stand-alone), as the influence of one measure on other impacts the overall marginal abatement cost[1]. Such interactions are rarely considered in MACCs. Thus, considering the heterogeneity among farms and the interactions between measures would help to improve the value of MACCs and ultimately the choice of policies to reduce greenhouse gas emissions in agriculture (Eory, Pellerin, et al., 2018; Eory, Topp, et al., 2018; Moran et al., 2008, 2011).

In this thesis, we aim at closing this research gap by answering how interactions between mitigation measures and the heterogeneity between farms affect the cost-efficiency of measures and thus, the development of a MACC. We do so by developing a new approach using the detailed bio-economic farm model FarmDyn. By running individual farm simulations, we account for the interaction between four mitigation measures that do not reduce food production and consider the heterogeneity in

1 For example, when considering the interactions between a measure that reduces the herd (because of an increase in the number of lactations, for instance), this will influence the marginal abatement costs of other measures that also depend on the number of animals, such as the introduction of feed additives in their diets.

marginal abatement cost between 65 dairy farms in the Swiss case study region "Flaachtal". Our approach also allows us to determine which farm characteristics (such as size and number of dairy cows) affect the abatement potential by using a multiple linear regression analysis.

Previous studies have already used simulation models to account for the interaction between measures when developing a MACC. In some studies, the interactions have been accounted and evaluated by experts, which is a process that entails uncertainty in the results (Eory, Topp, et al., 2018; MacLeod et al., 2010; Moran et al., 2011). Other studies employing farm simulation models focus on finding the most cost-efficient combination of mitigation measures under the imposition of a carbon price or ceiling level for typical farms. However, none of these approaches consider the influence of farm heterogeneity and the interaction of farms in their simulations.

Source: Canva

Method

Our study focuses on 68 individual dairy farms from the Weinland region, Canton of Zürich. We use census data that captures the characteristic differences among farmers (see Kreft et al. (2020) for more details) and the farm optimization model FarmDyn (see e.g., Britz *et al.*, 2021) to calculate the reductions in income and GHG emissions at farm-level when applying the following mitigation measures and their interactions: i) replacing concentrate feed with legumes grown on the farm, ii) increasing the number of lactations per dairy cow, iii) applying manure using trail hoses and iv) introducing feed additives to reduce enteric fermentation of cattle. Those measures were chosen based on their potential to reduce emissions without compromising food production in the Swiss dairy context. FarmDyn runs a simulation for each farm in our sample calculating the changes in income and GHG for all possible combinations of mitigation measures while also calibrating each of these farms, based on their characteristics (such as arable land, available crops, and animal units). With the simulations' results we can compute the interaction effects by assessing the difference between the sum of stand-alone measures and the case in which the combination measures are applied. Moreover, using the simulations' outputs and the census data we use a multiple linear regression model to assess the influence of farm structural heterogeneity on the greenhouse gas abatement potential.

Results

The results show that when the four most cost-efficient combination of measures are applied, the percentage reduction of emissions with respect to the baseline is 16%. Moreover, by accounting for the interactions between measures, the total average abatement cost is reduced by 65.5%, i.e., from 197CHF/tCO2-eq for the stand-alone to 68 CHF/tCO2-eq for the MACC with interactions. However, considering interaction effects also reduces the abatement potential by 1.62%. Our MACC not only accounts for the interaction between measures, but also includes the heterogeneity in marginal abatement costs among farmers (represented by standard error bars in Figure 5.3 pg. 22 of the thesis). To our knowledge, farm structural heterogeneity has not been reported in MACCs. The consideration of this heterogeneity has important implications for policy design. For instance, if a price for CO_2 would be introduced (i.e., taxing greenhouse gas emissions), the consideration of structural heterogeneity implies that not the full abatement potential would be achieved but that some farms would still be better off by paying a CO2 price rather than reducing greenhouse gas emissions. Without considering this heterogeneity, MACCs overestimate the potential of CO2 prices because they would imply that the corresponding potential is fully achieved. In addition, our MACC also allows to identify mitigation measures that imply cost savings while reducing GHG emissions.

The results from the regression analysis show which farm characteristics explain the abatement potential of GHG emissions. Based on the relationship between the farm characteristics and the abatement potential (i.e., whether it is positive or negative), we can interpret how the different farm attributes relate to the mitigation measures. We find that characteristics related to farm size, i.e., in terms of arable land and number of dairy cows, has a significant positive linear relationship with the abatement potential. This can be linked to the fact that an increase in arable land allows to replace crops by livestock fodder, as suggested by measure i) replacing concentrate feed with legumes grown on the farm. Moreover, farmers with higher values of arable land can have more dairy cows, meaning that dairy cows suppose an opportunity to abate GHG emissions, as the associated emissions can be directly addressed with measure ii) increasing the number of lactations per dairy cow. Therefore, an increase in arable land and dairy cows implies an increase of the farm's opportunity to increase abatement potential.

Conclusion & Policy implications

The results of this master thesis highlight the importance of accounting for the interactions among climate change mitigation measures as well as the heterogeneity of marginal abatement costs among farms. Considering the interactions between measures implies that a higher cost-efficiency can be achieved with little trade-offs with respect to the total abated emissions. From a policy perspective, these results provide information about the most cost-efficient mitigation measures when considering interactions and structural heterogeneity. This has implications on how to design policy incentives such as direct payments. For instance, if payments are granted based on the application of certain mitigation measures (i.e., for the use of feed additives), policymakers should consider the possible reduction in abatement costs due to interactions with other mitigation measures already implemented (having more lactations). Moreover, our results also help policymakers identify which are the farm characteristics that influence the most the abatement potential of the considered measures, and thus, tailor policy incentives to certain farm types.

Including the heterogeneity in marginal abatement costs in the MACC also helps identifying the uncertainty in achieving abatement targets.

While this study provides a new approach to develop MACCs, our results could be improved by considering further mitigation measures and extending our sample and considering other production types. In addition, despite reducing 16% of the emissions with the considered measures, further mitigation efforts need to be taken to meet international reduction goals. This implies that future research should focus on accounting for changes in production as well as a reduction in meat consumption.

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Price risks in milk markets – does geographical indication matter?

Simon Hug

The economic importance of ruminant-based milk products is vital for a country with a lot of natural grassland like Switzerland. At 2.47 billion Swiss francs, dairy farming accounts for a quarter of Switzerland's total agricultural production value (Federal Office for Statistics, 2021). Simultaneously, agriculture is strongly characterised by two limiting key attributes: uncertainties and risks. Sources thereof often lie in markets, institutions or production itself and have led farmers to a large and growing portfolio of risk management strategies (Meraner & Finger, 2019). In Swiss dairy production, price risks are the major source of farmers' revenue risks and may even increase through further market liberalisation and deregulation (El Benni & Finger, 2013). In the past, government support for the dairy market was able to provide some stability to farmers. However, for the future, strong, market-based risk management tools are crucial to meet the challenges of fluctuating raw milk prices and to remain consistent with the WTO Agreement on Agriculture to reduce producer subsidies (Huber, 2022).

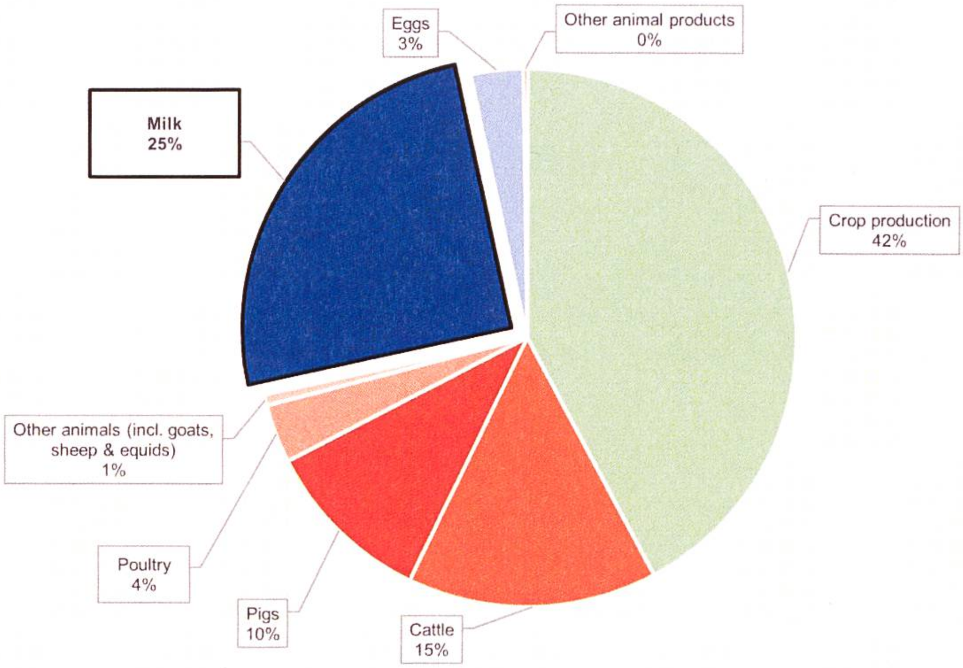

Figure 1. Estimated production value of the Swiss agricultural sector for 2020 in % (Federal Office for Statistics, 2021).

One promising approach to dealing with risks in a more market-oriented manner comes with a quality strategy that promotes less easily substitutable goods (Hillen & von Cramon-Taubadel, 2019). Products that are differentiated in terms of their geographical origin can lead consumers to perceive them as superior and increase their willingness to pay (Menapace et al., 2011). A solution that bears the potential to stabilise the Swiss milk market, which has been characterised by price fluctuations and overproduction since the abolition of milk quotas in 2009 (Forney & Häberli, 2014). With the label "Appellation d'origine protégée" (AOP), Switzerland already has a means of differentiating cheese – the most important use of milk (Swiss Milk Producers et al., 2020) – in terms of geographical origin. While recently published studies address the issue of price risks for agricultural products through vertical transmission analyses (Hillen, 2021) or price volatility dynamics in entire value chains of geographically indicated products from other European countries (Ferrer-Pérez et al., 2020), the impact of the AOP label as a market-based risk instrument in the Swiss cheese milk market has not been sufficiently understood so far.

Linking to this research gap, the master's thesis contributes to the question whether and how the Swiss geographical indication (GI) label "Appellation d'Origine Protégée" (AOP) influences the dynamics in cheese milk prices in two ways. First, horizontal price transmission analyses were conducted on farm-gate producer milk prices paid by cheese producers that process milk into Gruyère AOP, Emmentaler AOP, other artisanal cheese, industrial cheese or other dairy products. A vector autoregression model (VAR) and a vector error correction model (VEC) were estimated to detect horizontal price transmission effects for each combination of price pairs.

Second, analyses on horizontal volatility spill-over effects were carried out by estimating BEKK-MGARCH models according to Engle & Kroner, 1995. All empirical analysis steps were performed for milk prices provided by the Federal Office for Agriculture at both national and regional levels for the period from January 2000 to December 2021. Through this spatial and temporal division, the research focus was particularly laid on determining how the prices and price volatility of milk processed into AOP-labelled cheeses are affected by prices and price volatility of other milk channels, and vice versa.

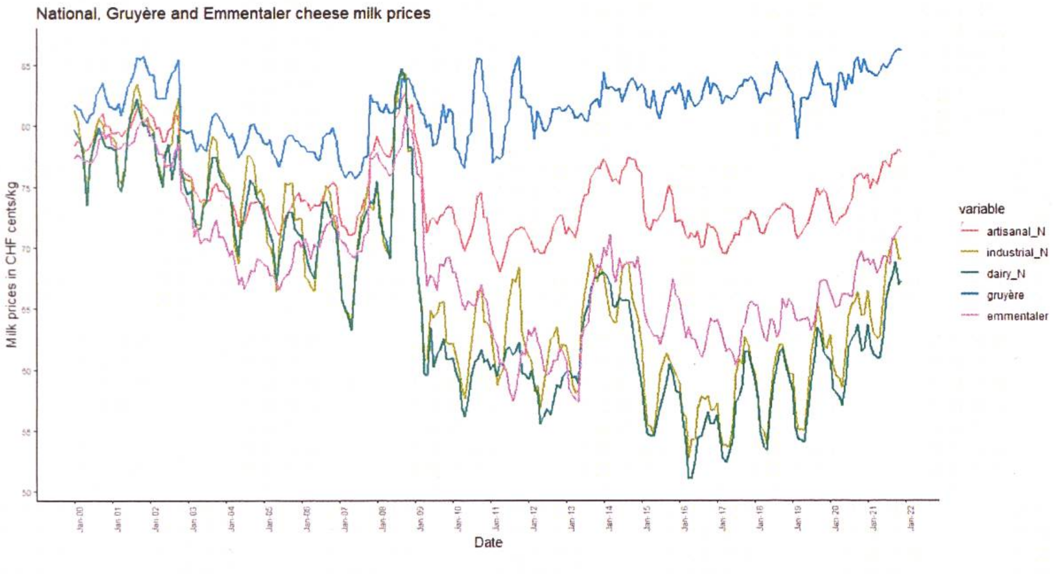

Figure 2. Monthly national, Gruyère and Emmentaler milk prices for the period of 2000 to 2021.

Capturing the extent of variability in relation to the respective mean, the coefficient of variation (CV) was compared for all milk markets considered in the study. Within each region, the CV were lowest for the AOP cheeses and artisanal cheeses. This highlights that for a specific region, the AOP and artisanal cheese milk prices were less volatile than industrial cheese milk prices and prices for dairy milk. When comparing between the regions, it particularly stands out that Gruyère AOP cheese milk prices showed exceptionally low coefficients of variation. The CV of industrially processed cheese milk and dairy milk prices, on the other hand, were high for all regions.

The results from the VAR model revealed that prices for dairy milk were a strong determinant for industrially processed cheese milk prices and other artisanal cheese milk prices, but not for Gruyère AOP milk prices. For both Gruyère AOP and Emmentaler AOP milk prices significant transmission effects from industrially processed cheese milk prices could be observed, while no or only few transmission effects in the opposite direction were significant. The VEC model applied to the few price pairs that showed significant cointegration indicated transmission effects from other dairy milk prices on Emmentaler AOP milk prices. The magnitude of this transmission was, however, smaller than the transmission of dairy milk prices on industrially processed cheese milk. Overall, dairy milk prices proved to be a stronger determinant for industrially processed cheese milk prices than for Emmentaler AOP, Gruyère AOP or artisanal cheese milk prices. The results from VAR and VEC models, therefore, support Gruyère AOP milk prices to be strongly resilient against short-term transmission effects from most other milk markets.

When it comes to volatility dynamics, the results from the BEKK-MGARCH model demonstrated that there were significant volatility spill-over effects between some price pairs. The resilience of Gruyère AOP against volatility spill-over effects from industrially processed cheese and dairy milk price volatilities was significantly strong. However, Emmentaler AOP seemed to be dependent on volatilities of other milk markets. Industrially processed cheese milk price volatility proved to be resilient against volatility spill-over effects from any milk market considered in the study.

Overall, the comparison of the coefficients of variation highlights that Swiss farmers producing milk for GI cheese have been exposed to lower price fluctuations over the last twenty years than milk producers for industrial cheese or the dairy channel. Furthermore, the empirical findings of the horizontal price transmission and volatility spill-over analyses confirm the importance of GIs as market-based means to reduce price risks in Swiss milk markets. The price transmission effects from dairy milk prices were stronger for industrial cheese milk prices without GI labels than for milk prices for cheeses with GI labels Gruyère AOP and Emmentaler AOP.

Milk prices for Gruyère AOP in particular proved to be resilient to volatility transmission effects from other prices, supporting the lower vulnerability of milk prices for GI cheese to volatility spill-over effects from other cheese and dairy milk markets. Although governance of intellectual property rights like GIs comes with additional costs, geographic indications are able to generate welfare gains (Moschini et al., 2008). Price risks can be moderated and the increased product transparency allows for better informed customer choices (Bramley et al., 2009). Ultimately, policy makers might improve market stability for Swiss dairy farmers, who produce milk for cheese by strengthening and expanding sales promotion through geographical indications.

The results of this thesis give rise to a number of considerations for future research. Transmission analyses in markets for AOP products other than cheese milk will increase the external validity and the extent of causal identification regarding the impact of GI labelling on Swiss producer prices. Additional insights could further be generated with a more holistic approach. Eventually, looking at a system rather than the bivariate case and also accounting for vertical transmission effects, as suggested by Hillen, 2021, could enable comparisons in price and volatility dynamics of whole value chain networks.

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