Impacts of decoupled subsidies

A case study of EU policies and impacts on trade in cheese

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SENSE PARTNERS
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1. Purpose

This report explores the effects of EU subsidies on trade in cheese. It has two main purposes:

- to test the proposition that decoupled subsidies do not distort trade
- to test whether standard frameworks for classifying and quantifying subsidies are fit for purpose in terms of:
    - understanding the effects of subsidies on international trade
    - negotiating changes to mutually agreed multilateral subsidy disciplines.

This is the second report in a series. The first report examined the effects of subsidies on trade in dairy products, broken down by the WTO amber, blue and green box classifications. That report found that amber and blue box supports are the most distortionary types of subsidies, as anticipated. But that report also presented evidence that green box subsidies are more than minimally trade distorting.

This report explores those results, in more detail, with a focus on direct domestic support payments that are classified as green box spending.

The analysis focusses on subsidies in the EU between 2010 and 2019 and on trade in cheese between 2013 and 2019. EU data on subsidies is readily available, more extensive, higher quality and more detailed than can be found anywhere else. This allows for detailed analysis of the effects of different types of subsidies and decomposing the effects of different payments that are classified as green-box spending.

Cheese is a useful product case-study because it is more widely produced and consumed than most other dairy products and thus easier for us to test connections between a range of categories of farm subsidies and manufactured dairy product trade.

The focus is on direct payments received by dairy farmers and the flow-on effects to supply of milk to cheese producers and subsequent impacts on dairy trade. The analysis excludes:

- market price supports, such as guaranteed minimum prices
- domestic food aid and public stockholding for food security purposes
- spending on general services such as research and education.

Future work will explore in more detail the mechanisms by which domestic support impacts dairy farm production, dairy product manufacturing and trade. It will also investigate empirical relationships between and cumulative effects of domestic support payments, market interventions, and market access barriers include tariff rate quotas.

The ultimate objective is to calibrate a single robust empirical model of global dairy trade with a focus on impacts from all policy induced distortions to dairy trade; built from a series of data-driven case studies.

2. Context

2.1. Conflicting ideas about subsidies

Economic theory has uncertain and often conflicting predictions about the effects of subsidies on production and trade.

There are two general perspectives. The first we refer to as the intensive margin argument. This says that subsidies only have a more than minimal effect on trade if payments incentivise production by being linked, or coupled, to production. Payments per unit of output or payments for producing a specific type of product are expected to increase production and exports and put downward pressure on prices and have a negative effect on producers that do not receive subsidies. On that perspective, payments that are not linked to – are decoupled from – production will have only minimal effects on trade because there is no incentive, at the margin, to increase production. The WTO Agreement on Agriculture is founded on this perspective (Stancanelli, 2009).[1]

The second perspective is that the extensive margin matters (Chau and de Gorter, 2005; Devadoss et al, 2016; Gibson and Luckstead, 2017). On this perspective, decoupled payments affect production by distorting incentives for firms or farms to exit or enter an industry or switch from producing one sort of product or another or to choose to export or not. The simple arithmetic of this is that firms that cannot cover their fixed costs will exit an industry. Lump sum payments, decoupled from production, provide cashflow that helps a firm or farm stay in business when it otherwise would have shut down. This can mean that production is larger than it otherwise would be and prices lower than they otherwise would be.

Other theories suggest that decoupled payments can affect the intensive margin of production through, for example, wealth effects or increasing farmers' willingness to take risks because decoupled payments act like an insurance policy for producers (Bhaskar and Beghin, 2009).

Most likely subsidies have effects on both the intensive and the extensive margins. However, the WTO agreement on Agriculture is predicated on the idea that the intensive margin matters most. As a result, most subsidies are considered only minimally trade-distorting. In the case of EU spending, over 75% of spending is assumed to be non-distortionary because it is decoupled (see Figure 1).

2.2. The EU as a case study

We focus on subsidies in the EU because the EU is the largest market for dairy products in the world, spends more on domestic support than any other WTO member, and has laudably detailed and readily available on domestic support.

[1] This was a political compromise. OECD advice at the time was that no payments can be fully decoupled from production incentives.

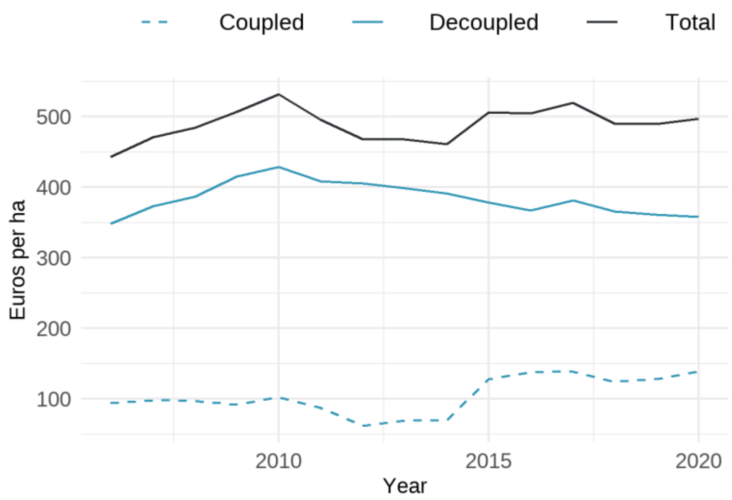
There is a substantial amount of empirical research on EU subsidies and their impacts on farm production. Though there is comparatively little recent empirical research of the effects of EU subsidies on international trade.[2]

Research results vary significantly depending on methods employed and sectors analysed (Minveil and Latruffe, 2017). Numerous studies find that decoupled payments have a negative effect on productivity growth, which is consistent with the idea that decoupled payments limit incentives to improve or exit the market (e.g. Boussemart et al, 2019). However, there are also studies that find that decoupled subsidies have a positive effect on productivity growth (e.g. Khafagy and Vigani, 2022; Nilsson and Wixe, 2022). Latruffe et al (2017) suggest that impacts of decoupling on dairy farms has varied by member state, depending on productivity of land and institutional arrangements such as whether land is typically rented or owned by farmers.

2.3. Measures of subsidies

The EU's transparency around farm payments provides a very useful window on the scope for misinterpreting data on subsidies, depending on the source. Consider, for example, the sort of data collected in WTO notifications against the data available in EU farm survey data (see Table 1). WTO notifications provide next to no value for understanding on-the-ground impacts of subsidies. EU data, however, is excellent.

FIGURE 1: EU DAIRY FARM SUBSIDIES, COUPLED VS DECOUPLED
Average € per hectare[3], inflation adjusted (2019 base year) [4]



[2] There is a substantial number of model-based estimates of the size of these effects, but these studies typically involve numerical simulations predicated on theoretical assumptions (e.g. computable general equilibrium modelling) rather than empirical estimation. E.g. Boysen-Urban et al, 2020.
[3] Source: FADN database. Specialist dairy farms.
[4] Approximation using EU CPI inflation (OECD.Stat).

EU farm survey data provides a breakdown of payments to dairy farmers by broad category of spending:

- Coupled subsidies, comprising
  - payments targeted at dairy/milk production (Dairy-specific)
  - Payments targeted at crop-production (Crop-specific)
  - payments targeted at livestock production (Livestock-specific)
  - payments for inputs and other costs such as rent or interest (Inputs and other)
- Decoupled subsidies intended to support
  - investment
  - rural development (including environmental programmes)
  - farmers incomes (decoupled income support).[5]

The EU data is both product- and producer-specific. Thus we can observe that dairy farms are the main recipients of milk production subsidies (€820 million), but that a substantial amount of those subsidies (€240 million) are received by farms that do not specialise in milk production. In contrast, the WTO notification simply records the total of those payments as voluntary coupled support (€914 million) and product-specific support for milk (€199 million).[6]

TABLE 1: DOMESTIC SUPPORT MEASURES, EU SURVEY COMPARED TO WTO FORMAT
€ millions, 2019

FADN data	Farm type			**WTO notification**	
Subsidy type	Dairy	Other	All	Milk	199
Investment	210	890	1,100	Butter, price support*	3,104
Rural development	1,850	9,420	11,260	SMP, private storage costs	1
Decoupled income support	5,090	30,510	35,600	Sub-total, amber box	3,304
Dairy-specific	820	240	1,060		
Livestock-specific	310	2,230	2,530	Voluntary coupled support	914
Crop-specific	50	1,780	1,840	Sub-total, blue box	914
Inputs and other	690	3,160	3,850		
Total	9,020	48,220	57,240	Total, product specific	4,218

[5] These payments have had different official names over time, such as single farm payments and basic payments.
[6] These amounts do not match due to different source data and different but overlapping tie periods. But they broadly align.

The EU survey data is much more useful because it is likely that payments to specialised milk producers have a much more substantial effect on trade by virtue of those farms being more likely to supply large scale dairy product manufacturers. Farms not specialising in milk production are, intuitively, more likely to supply milk in small quantities in local markets, including drinking milk that is not further processed and so does not enter international trade.

The EU survey data also shows support to milk production specialists that is around double the size of support to milk and dairy product production inferred by the WTO data. Furthermore, the WTO data is misleading in the fact that three-quarters of the product-specific support comprises butter price support that is of questionable significance, seeing as the intervention price that would have triggered that support was, in 2019, substantially below the market price. So, while this is rightly defined as a domestic support measure, the value that is attached to it is highly questionable if one is trying to understand the effects of domestic support on dairy production.

It is important to know where – to what industries - subsidies are going because the practical consequences of that support, whether or not it is decoupled, will be dictated by whether it is concentrated in particular industries. WTO notifications shed little light on this.

The OECD's producer support estimates provide a rich and broad set of information about producer support spending in OECD and several non-OECD countries. We have used this data to estimate the scale of support generally available in countries outside the EU (see Appendix), by producer type and by WTO classification (see Table 2).

But, similar to the WTO data, the OECD data does not contain direct measures of support by industry. The is illustrated in Table 3, showing that an estimated of producer support to dairy farming, using the OECD data, yields an estimate of support that is substantially lower than the EU survey data. Furthermore, the OECD data can potentially lead to an overestimate of coupled support, if one were to include livestock payments in the scope of dairy payments – because it is not possible to observe how much of those payments go to dairy producers versus other producers.

TABLE 2: DOLLARS OF SUBSIDIES BY WTO BOX AND TARGET SECTOR OVER TIME

US dollar millions, based on OECD producer support estimates

Box	Supplied to	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Amber	Dairying	3,407	2,473	2,612	2,917	3,536	2,074	1,886	1,920	1,972	1,893	2,033
	Ruminants	6,233	6,353	7,755	8,190	6,788	5,587	2,620	2,496	2,161	2,110	1,800
	Livestock	3,570	3,594	6,668	6,857	8,365	7,374	6,091	5,820	6,350	6,719	6,190
	Any producer	46,098	43,551	47,983	49,182	48,779	49,141	51,342	52,490	59,928	60,135	58,327
Blue	Dairying	241	281	311	330	333	315	1,175	1,208	1,253	1,327	1,270
	Ruminants	98	91	91	85	88	98	2,501	2,629	2,760	2,800	2,622
	Livestock	338	361	399	406	412	397	323	282	265	311	275
Green	Dairying	0	65	72	72	59	56	49	54	54	54	420
	Ruminants	60	56	52	49	55	54	62	61	63	63	57
	Livestock	1,149	1,838	1,092	887	812	673	903	786	815	793	816
	Any producer	91,097	91,918	98,702	95,550	98,816	102,130	86,375	87,870	87,623	93,952	102,647
Total	Total	152,290	150,582	165,738	164,525	168,044	167,899	153,326	155,616	163,244	170,156	176,456

TABLE 3: SUBSIDY MEASURES, EU SURVEY COMPARED TO OECD

*Product scope for dairy includes dairy-specific payments + livestock payments that might impact dairy, based on being available to ruminant livestock or all/any livestock. Note also market price support evaluated to be 0 in 2019, in contrast to the €3.1b WTO measure of market price support.

	EU FADN farm type:			OECD PSE, product scope:			
Subsidy type	**Dairy**	**Other**	**Total**	**Dairy***	**Other**	**Total**	
Investment	210	890	1,100	180	5,390	5,570	
Rural development	1,850	9,420	11,260	560	18,740	19,300	
Decoupled income support	5,090	30,510	35,600	0	36,830	36,830	
Dairy-specific	820	240	1,060	1,190	0	1,190	Amber & blue box (approx.)
Livestock-specific	310	2,230	2,530	2,990	0	2,990	
Crop-specific	50	1,780	1,840	0	3,780	3,780	
Inputs and other	690	3,160	3,850	140	6,360	6,500	
Total	9,020	48,220	57,240	5,060	71,100	76,160	

2.4. Industry concentration of support matters

Industry concentration of support matters to the extent that it may be impacting production by keeping resources in a particular activity even if that activity is inefficient. Firms and farms with product-specific plant and equipment or knowledge and skills will likely be disinclined to change to some other activity. Decoupled support can shield those producers from incentives to change.

The WTO perspective on this is that as long as the supports are generally available to producers regardless of what they produce then this is not distortionary. However, this overlooks the fact that generally available subsidies in a country that specialises in dairy production becomes a de-facto product-specific support.

A country might be specialised in dairy production because it has a comparative advantage. It might also be that that specialisation was built on domestic support. That is, if a country has built up an industry with coupled subsidies and then shifts to an alternative allocation mechanism that is independent of output or industry type, the support will continue, for all practical intents and purposes, to flow to the previously favoured industry, at least for some time.

In the EU, member states also have discretion over how they allocate payments for farmers. This is one reason why there is substantial variation in the intensity of support to dairy farms, even after accounting for the size of member states' dairy production (see Figure 2). In some member states, dairy does not receive a large share of subsidies. Possibly because those members are not specialised in dairy production. And in many of those member states subsidies are an important share of income, and farmers receive decoupled and coupled support (Figure 3).[7]

[7] Note that farm survey data for dairy farming in Greece and Cyprus is sparse. Consequently we have used OECD producer support measures alongside EU disclosure data to estimate dairy subsidies for those member states.

FIGURE 2: SUBSIDIES ONLY ROUGHLY ALIGNS WITH SECTOR SIZE

Horizontal axis is dairy farming's size, within a member state. Vertical axis is dairy farming's share of subsidy payments. Bubble sizes are value of dairy farm output. Data is for the year 2019. Dotted grey line depicts equality of payments share and output share.

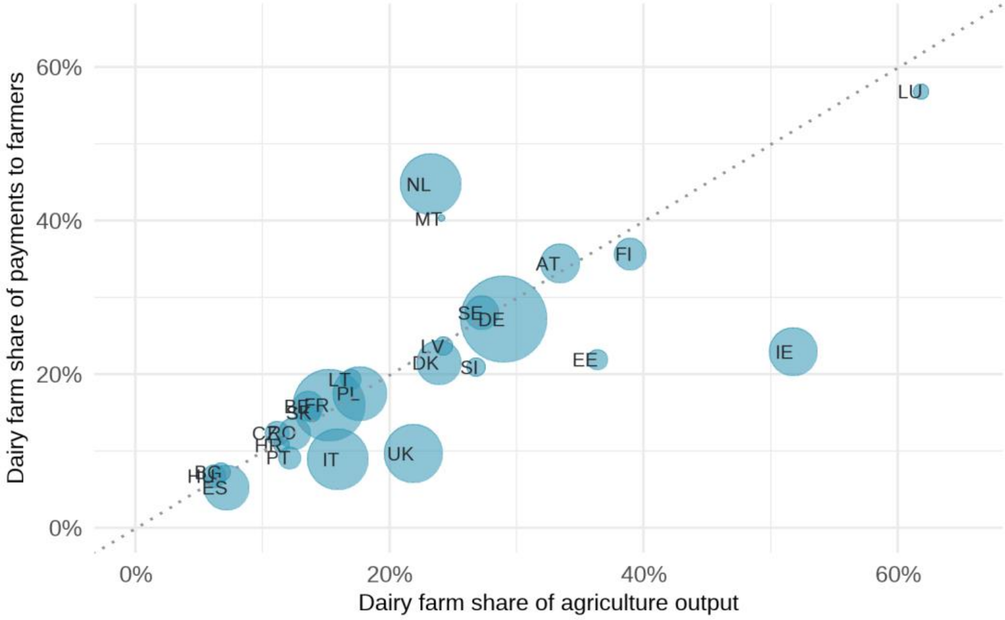
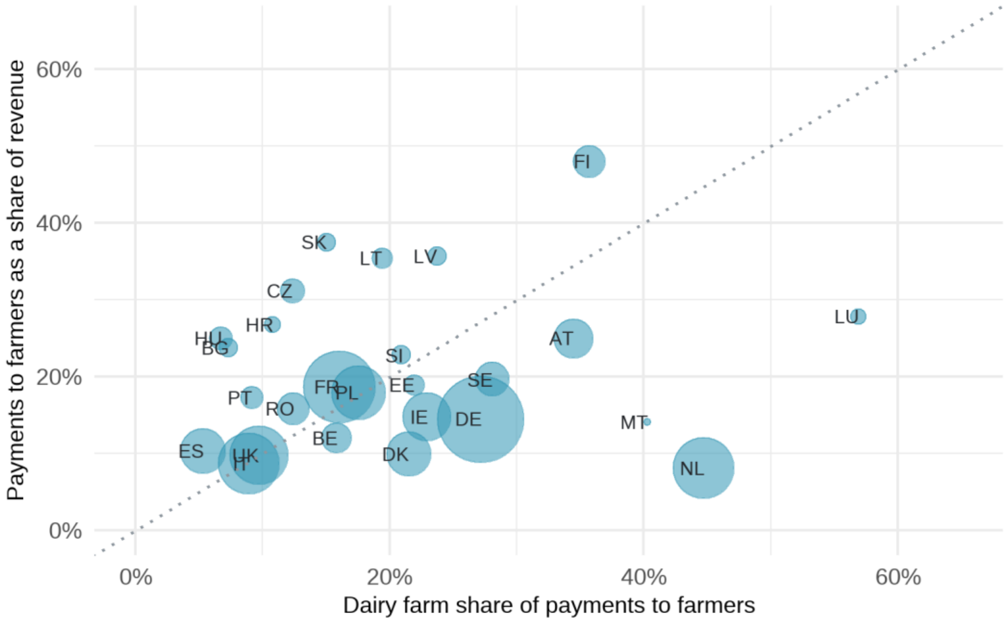


FIGURE 3: WIDE VARIATION IN SHARES OF SUBSIDIES IN FARM INCOMES

Horizontal axis is dairy farming's share of subsidy payments. Vertical axis is subsidy payments as a share of farm revenue. Dotted grey line depicts equality of payments share and output revenue share.



3. Impacts of EU subsidies

3.1. Identifying policies that affect trade

We have used machine learning methods to identify which subsidies affect trade in cheese. The methods we use are adapted from a relatively recent World Bank working paper by Breinlich et al (2021).

We construct a model where trade in cheese is assumed to be predicted by policies, production, and consumption. We include all of the types of dairy sector subsidies for, which we have data, and other policies such as tariffs, FTAs, and EU milk quotas.

We let a statistical algorithm select the combinations of policies that best predict trade (alongside the other policy predictors).[8] A benefit of using this sort of method is that it substantially reduces the amount of subjective judgement required in selecting which policies to include in the analysis. The model selects those that have predictive power and drops those that don't.[9]

Subsidies that were selected by the model with the lowest prediction errors are shown in Table 4 alongside the estimated effect of these policies as tariff-equivalent effects on trade costs. Positive values imply that the policy is, on average, cost increasing and has a negative effect on EU exports. Negative values imply that the policy is on average cost decreasing and stimulates exports.

The Intra-EU effects are a combination of the main export effect adjusted to account for different impacts when trade is between to EU countries.

Decoupled income support is associated with lower costs of production and increased exports of cheese. These effects are strongest within the EU; an unsurprising result because intra-EU trade faces substantially lower trade barriers (tariffs and quotas and distance and consumer preferences), than trade with other countries.

Coupled support also has positive effects on exports and these effects are stronger, per dollar of support, than decoupled income support. Spending on decoupled income support is 6 times larger than spending on dairy-specific coupled support but the effect of decoupled income support on exports is only roughly twice the size of impacts of dairy-specific coupled support.

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[8] The modelling assumes that bilateral cheese trade, across all countries, is always affected by: domestic demand, domestic production, and persistent bilateral trade frictions such as distance and cultural similarities. These factors are not subject to selection in the modelling. Though the modelling does estimate the size of those effects.

[9] Another benefit of this method is that it allows us to capture effects of highly correlated variables, where usually they would have to be dropped. Many of our variables are highly correlated because, for example, shares of domestic support spending are relatively stable while the levels of those components rise and fall together along with overall domestic support – the domestic support tide raises all domestic support boats. Thus making it difficult to disentangle the effects of overall spending from components of spending with conventional methods.

Higher amounts of rural development spending and investment support are associated with higher costs of production and reduced exports.

The results in Table 4 are policy effects from the model with penalised effects (i.e. coefficients). These are generally smaller than the effect sizes we get if we use the penalised model to select policies that predict trade and then estimate the policy effects post-selection and without penalties. Details on model effect sizes and sensitivity are set out in the policy coefficients section of the model details appendix.

TABLE 4: IMPACT OF SUBSIDIES ON EXPORTER UNIT COSTS
Average effects evaluated as tariff equivalents. Positive values are cost increasing (taxes). Negative values are cost decreasing (subsidies). Effects are mean 2019 values.

Type	Policy	Exports	Intra-EU
Decoupled, EU	Investment	2.6%	1.6%
	Decoupled income support	-5.7%	-8.6%
	Rural development[10]	4.7%	4.5%
Coupled, EU	Crop-specific	-1.1%	-0.6%
	Dairy-specific	-2.7%	-5.2%
	Livestock-specific[11]	-0.8%	-1.5%
	Inputs and other	-0.8%	-0.7%
Decoupled, non-EU	Broad measure of green box	1.3%	
Coupled, non-EU	Broad measure of amber box	-0.3%	
	Broad measure of blue box	-1.6%	

The model captures dynamic effects of subsidies by admitting contemporaneous effects and lagged effects. This allows us to account for industry adjustment and policy adjustment and net effects over time.

For example, the model results suggest that an increase in decoupled income support initially has negative effects on trade, possibly capturing changes in production incentives when the structure of subsidies changes. It may also be capturing reverse causality (endogeneity) in policy decisions and trade. If member states increase (decrease) support payments when industry is facing a negative (positive) shock. Nonetheless, the accumulated net effect on trade over time is to stimulate exports.

3.2. Impacts of subsidy reform

[10] Note that the effect (cost) of rural development spending on intra-EU trade is an unstable result, with the coefficient changing sign depending on the penalty used in the model. However, the net effect on total exports (a cost that reduces trade) persists. See the model appendix for sensitivity analyses.

[11] The effect (cost) of subsidies to livestock farming on exports from the EU is an unstable result, with the coefficient changing sign depending on the penalty used in the model. However, the net effect on EU member state exports (extra-EU trade plus intra-EU trade) is consistently positive. See the model appendix for sensitivity analyses.

To estimate the overall impacts of decoupled subsidies on trade in cheese we simulate reductions in subsidies to dairy farms. For each component of EU subsidies, we simulate an arbitrary 50% reduction in payments. The results of these simulations are shown in Table 5.

The simulations focus on incremental impacts on trade flows and on factory-gate prices. Production volumes (but not values) are assumed to remain constant.[12]

Decoupled income support is the most distortionary

A key result from these simulations is that decoupled income support is estimated to be having a material stimulatory effect on EU exports and displacing exports from other countries. This lift in EU exports is depressing prices for internationally traded cheese outside of the EU; the average effect size is modest but material with non-EU prices 0.4% lower and EU exports 1.7% higher than they otherwise would be.

Of all the categories of subsidies, decoupled domestic support has the largest effect on trade. This is doubtless because of its sheer size and widespread use in the EU. While production incentives – and indirectly export incentives – might be stronger with coupled support, the fact that decoupled support is large and full decoupling impossible means that distortions to trade remain.

Substantial variation in impacts across the EU

The average effects of reform, shown in Table 5, disguise substantial variation within and outside the EU.

Within the EU, the size of a 50% reduction in decoupled income support does not have an equal effect on export trade costs, because there is variation in the starting position – the level and composition of support and in production capacity and domestic demand – across EU members.[13]

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[12] Though this perspective is incomplete, a more complete analysis of the flow-on effects to plant and farm investment and then to cheese production volumes requires a broader view of the effects of policies on other products and prices, considering EU market intervention mechanisms. Analysis of market intervention policies is planned for future work.

[13] Furthermore, more mechanically, in our simulations there are differences in the relationship between EU domestic support and EU trade over time, discussed in the previous section, which mean that in a single year the effect of reducing domestic support is not equal across member states. The net effect will depend on whether domestic support is growing or reducing over time and which kinds of domestic support are growing or reducing.

TABLE 5: SIMULATED IMPACTS ON CHEESE TRADE OF A 50% REDUCTION IN SUBSIDIES BY TYPE OF SUPPORT

Price changes are averages weighted by pre-reduction (base year 2019) trade shares. Other % values are changes in nominal trade values.

Subsidy type	Base year farm subsidies (€m)	Reduction in subsidies, €m and % of total		EU prices	Non-EU prices	EU exports	EU imports	Intra-EU trade	Non-EU exports
Coupled support									
Dairy-specific	820	-410	-4.5%	0.3%	0.1%	0.0%	1.9%	-2.1%	0.6%
Crop-specific	50	-25	-0.3%	0.0%	0.1%	-0.5%	-0.4%	-0.2%	0.2%
Livestock-specific	310	-155	-1.7%	0.2%	0.1%	-0.1%	0.8%	-0.6%	0.2%
Inputs and other	690	-345	-3.8%	-0.2%	0.1%	-0.7%	-1.4%	-1.5%	0.1%
Sub-total, coupled support	1,870	-935	-10.4%	-0.3%	0.1%	-0.9%	0.0%	-4.8%	0.4%
Decoupled support									
Investment	210	-105	-1.2%	1.2%	0.1%	-0.1%	3.1%	2.7%	0.5%
Decoupled income support	5,090	-2,545	-28.2%	-0.5%	0.4%	-1.7%	0.8%	-13.9%	1.0%
Rural development	1,850	-925	-10.3%	1.9%	0.2%	-0.1%	5.2%	6.7%	0.8%
Sub-total, decoupled support	7,150	-3,575	-39.6%	1.3%	0.1%	-0.7%	7.2%	-6.8%	0.4%
Total	9,020	-4,510	-50.0%	3.9%	2.4%	3.0%	9.8%	-9.2%	8.0%

For example, our estimates of the effects of dairy-specific coupled supports are sizable, at the margin, but the results of the subsidy-specific simulations are more muted than we might have expected due to interactions, via relative cost effects, with other forms of support that remain in place.

Similarly, rural development spending, which we estimate to have negative effects on trade at the margin, is associated with a small increase in EU exports and a small reduction in non-EU prices. We interpret this as being due to the negative effect that this support has on the competitiveness of its recipients – whether through accompanying compliance requirements, non-production objectives, or favouring production in high cost (less-favoured) areas. This reduces intra-EU trade and increases domestic supply in local markets for local markets. It also means a smaller market within the EU for products produced by more competitive suppliers. The more competitive producers then export some of their products.

Some of this variation in effects can be seen in the change in trade flows summarised in Figure 4 (additional results for other simulated reforms can be found in Appendix 1), reflecting the impact of a 50% reduction in decoupled income support. Changes in trade flows are largest in the Eastern and Southern European member states, where prices increase by up to 6% as imports from Western Europe decline. Imports from the rest of the world increase, but these increases are limited due to other barrier to trade. While there is a significant percentage increase in imports from, for example, Latin America and Oceania, those increases are from a small base.

In contrast, prices in many Western and Northern European countries decline by 1% to 2% as substantial amounts of export trade is diverted to the domestic market.

More generally, it is worth bearing in mind that the effect of subsidies on international trade depends on:

- the incremental effect of that support on costs (i.e. per Euro of support), plus
- the size of the subsidies, plus
- the size of the sector receiving the support plus
- the effects of all other domestic supports provided and trade policies in place at home and abroad.

A modest input cost advantage to a large cheese producer/exporter, with advantages in e.g. energy costs and skilled labour, is substantially more impactful to international trade than a large cost advantage to a small producer that is comparatively inefficient in all other respects.

Cumulative effects of all supports, dominate individual categories

Overall, it is the totality of domestic support that matters; given differences in composition of support, intensity of support, and respective comparative advantages.

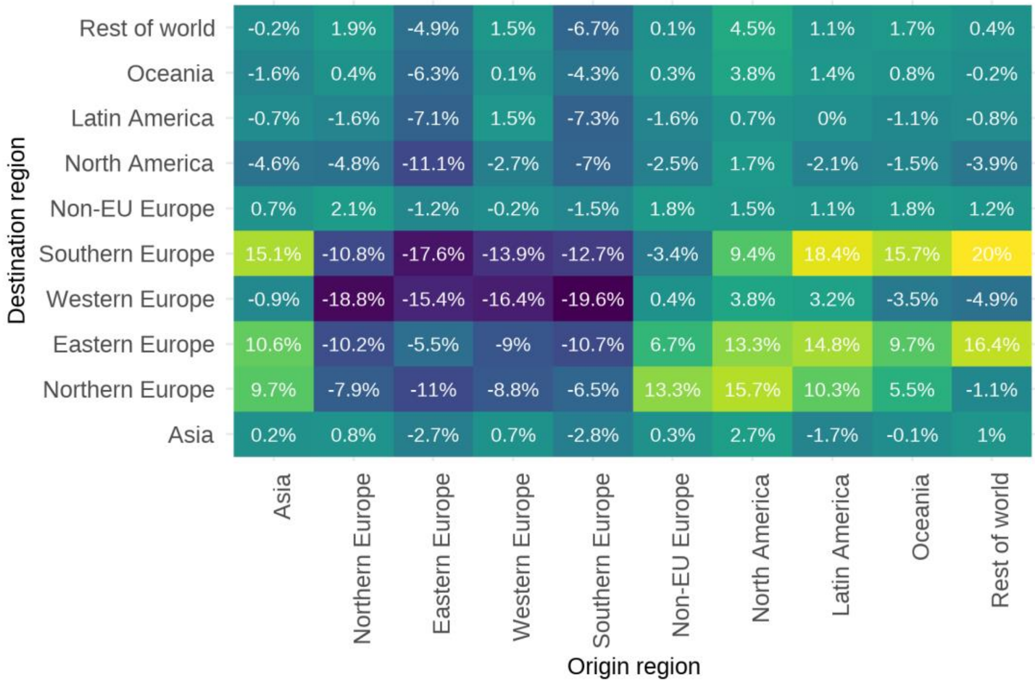
No single category of subsidies stands out, in our results, as being a good single starting point for reducing distortions to international trade from EU subsidies.

Rather, the effect of across-the-board reductions is, in general, greater than the sum of the parts – from the perspective of reducing international trade distortions.

The overall results suggest that an across the board 50% reduction in subsidies would increase producer prices, on average, in the EU and in non-EU countries by 3.9% and 2.4% respectively. The value of EU exports would increase by 3.0% and the value of non-EU exports would increase by 8.0%.

FIGURE 4 IMPACT OF A REDUCTION IN DIRECT DECOUPLED INCOME SUPPORT

Percent change in trade flows between regions. Non-EU European countries grouped as a single region. All other regions labelled European are comprised solely of EU member states.



3.3. Sensitivity analyses

The results outlined above are somewhat sensitive to model specification. In particular the use of unpenalized (post-selection) models does change the results for some of the components of subsidies.

The results above, tend to show smaller distortions to trade than we obtain with unpenalised estimates of trade costs. Although the sensitivity tests do not reverse any overall conclusions.

Table 6 below presents ranges (minimum and maximum) simulation results with alternative specifications.

TABLE 6: RANGE OF SIMULATION RESULTS, SENSITIVITY ANALYSIS

Values are minimum and maximum (format: min, max) percent changes from simulated 50% reduction in support with 6 variations based on varied penalty values and use of penalised and unpenalised (post-selection) coefficient values for policy effects.

Subsidy type	EU prices	Non-EU prices	EU exports	EU imports	Intra-EU trade	Non-EU exports
Coupled support						
Dairy-specific	-0.3% , 1.0%	0.1% , 0.3%	-0.8% , 0.2%	-0.1% , 4.3%	-2.7% , -1.2%	0.2% , 1.2%
Crop-specific	-0.1% , 0.1%	0.1% , 0.1%	-0.6% , -0.3%	-0.7% , 0.1%	-0.3% , -0.1%	0.2% , 0.3%
Livestock-specific	0.1% , 0.3%	0.1% , 0.1%	-0.2% , 0.1%	0.4% , 1.2%	-0.8% , -0.5%	0.2% , 0.3%
Inputs and other	-0.3% , -0.1%	0.1% , 0.1%	-0.9% , -0.7%	-1.9% , -1.2%	-2.0% , -1.0%	0.1% , 0.2%
Sub-total, coupled support	-0.7% , 4.8%	0.1% , 2.5%	-4.0% , -0.8%	-1.5% , 8.1%	-5.8% , 1.0%	0.1% , 7.6%
Decoupled support						
Investment	0.3% , 1.6%	0.1% , 0.1%	-0.2% , 0.0%	0.7% , 4.6%	1.0% , 3.7%	0.2% , 0.5%
Decoupled income support	-0.5% , 3.5%	0.2% , 2.5%	-7.1% , -1.2%	0.8% , 5.5%	-13.9% , -11.1%	0.5% , 7.4%
Rural development	0.9% , 2.8%	0.1% , 0.2%	-0.3% , 0.1%	1.7% , 8.9%	3.8% , 8.5%	0.5% , 1.1%
Sub-total, decoupled support	0.3% , 4.3%	0.1% , 2.4%	-0.7% , 8.5%	3.5% , 12.6%	-7.9% , -2.0%	0.3% , 8.5%
Total	3.9% , 4.0%	2.4% , 2.4%	-4.0% , 7.4%	7.3% , 11.9%	-9.2% , -7.2%	7.6% , 8.3%

3.4. Implications

These results suggest that negotiations over subsidy disciplines ought to be broadened to consider the effects that large amounts of income support may be having on international trade.

Focussing on coupled support, while perhaps an important political compromise in the past, has outlived its purpose. Decoupled subsidies are more than minimally distorting trade.

The results also suggest that treating decoupled subsidies – or green box subsidies – as a single category of support is a mistake. There is evidence that different categories of support have different effects, such as the finding that development spending is associated with reduced exports and income support with increased exports.

It is likely that some of the relationships we observe between categories of support and export trade are due to selection effects. That is, for example, countries with more competitive producers or more commercially oriented industry policy favour decoupled income support while countries with less competitive producers or more environmentally oriented industry favour comparatively large amounts of rural development spending. The methods we have used mean that we have not fully controlled for this and "we need to be very humble about potential causal interpretation of our results" (Breinlich et al 2021, p.15).

But the possibility of selection effects does not diminish the importance, for international dairy trade, of the general observation that a substantial proportion of decoupled domestic support in the EU is associated with increased cheese exports. If a sector is internationally competitive, why would there be any need to provide significant support to a major supplier of that sector, whatever its composition?

If decoupled income support is associated with increased farm productivity in some member states (Latruffe et al, 2017), but not others, then selection into decoupled income support may be lending advantage to more competitive producers so that, per dollar of domestic support, there is a greater impact of subsidies on exports and international markets than there would otherwise be.

Finally, we emphasise that this analysis was only possible because the EU measures the details of its subsidies and who receives that support. We have found that the totality of subsidies matters, for understanding trade effects. But we have only been able to analyse spending in the EU, in any detail, so our analysis is incomplete.

Data on domestic support needs to include information on recipients of subsidies, rather than simply the overall scale of spending. This would substantially improve the ability of industry, governments, researchers, and other stakeholders in understanding the costs and benefits of domestic support.

Appendix 1: Additional figures

FIGURE 5: IMPACT OF A REDUCTION IN RURAL DEVELOPMENT SPENDING

Percent change in trade flows between regions. Non-EU European countries grouped as a single region. All other regions labelled European are comprised solely of EU member states.

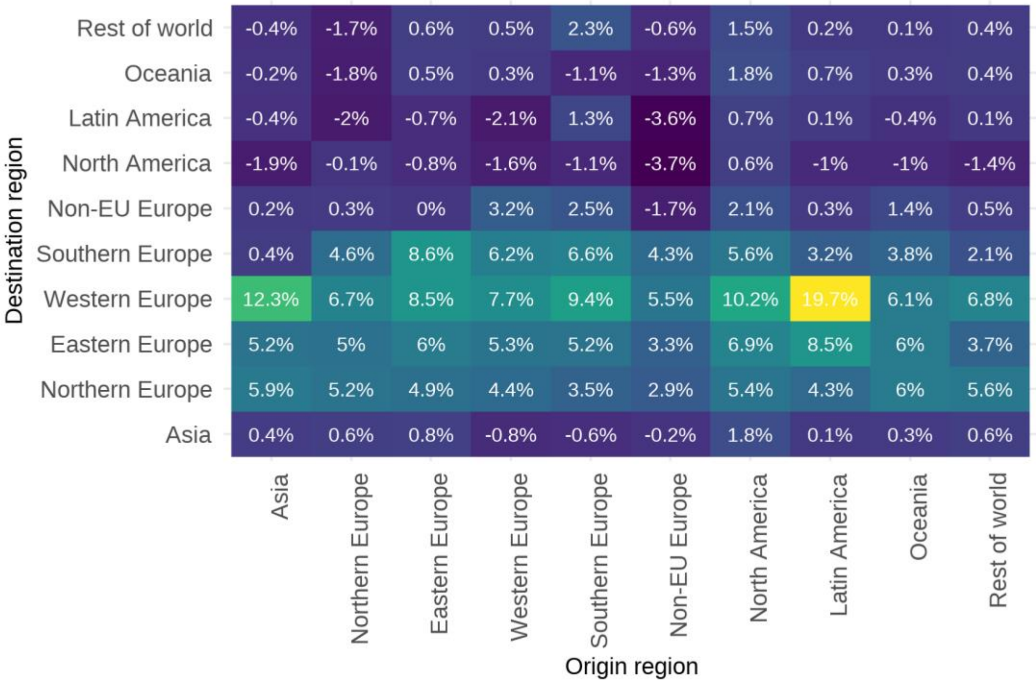
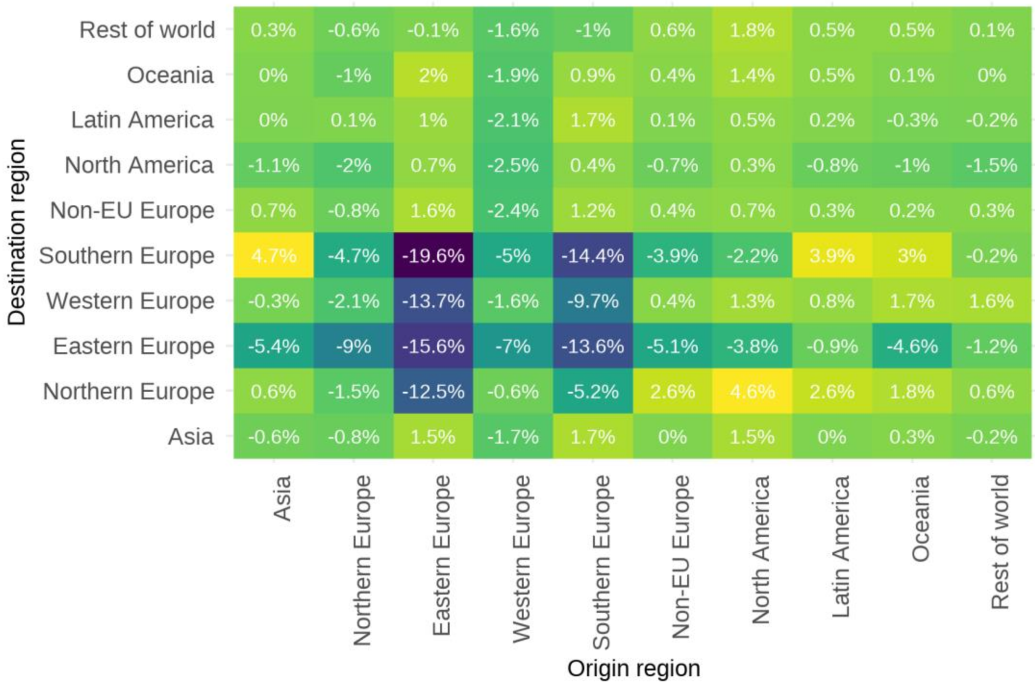


FIGURE 6: IMPACT OF A REDUCTION IN COUPLED SUBSIDIES

Percentage change in trade in cheese. Simulated result of 50% cut to EU subsidies that are coupled to production.



Appendix 2: Estimates of non-EU domestic support

OECD data on producer support estimate (PSE) data has been assigned to WTO categories (boxes) as outlined in the table below.

FRAMEWORK USED TO ASSIGN POLICIES TO BOXES

Payment Categories	Basis Detail	WTO category	Exceptions
Payments based on output	Price	Amber - MPS	None
	Output	Amber	None
Payments based on animals, area, income or receipts	Current activity production required	Amber	Green if contains 'Environment', 'Disaster', 'Insurance' but only if not a single commodity transfer (SCT) or group commodity transfer (GCT). Amber if SCT or GCT and with no payment limit.
	Past activity, production required	Blue	Data includes indicators for whether payments come with limits on total amount, variable or fixed rates, or input constraints e.g. prescribed farming methods for environmental purposes.
	Past activity, no production required	Green	None.
Payments based on input use	Capital	Amber	Green if contains 'Environment', 'Disaster', 'Insurance' but only if not a single commodity transfer (SCT) or group commodity transfer (GCT).
	On-farm services	Green	Amber if SCT. This may admit SPS programmes as amber, but equally overlooks GCT that may be trade distorting (e.g. animal reproduction programmes).
	Materials	Amber	Green if contains 'Environment', 'Disaster', 'Insurance' but only if not a single commodity transfer (SCT) or group commodity transfer (GCT). Also 'Regional assistance' green if not SCT or GCT.
Non-commodity criteria	Resource retirement	Green	None
	Non-commodity output	Green	None
	Other	Green	None
Miscellaneous payments	Misc	Green	None. A default position pending more precise information.

For this paper we have excluded from analysis any WTO green box support that falls within the OECD's General Services Support Estimate (GSSE). This means the following categories of spending, mentioned in Annex 2 of the WTO Agreement on Agriculture, are not included in this analysis:

- general services (e.g. research, training, inspection services)
- public stockholding for food security purposes
- domestic food aid.

All other categories of spending listed in Annex 2 of the Agreement on Agriculture are included in the analysis, including decoupled income support.

Appendix 3: Model details

General form of the theoretical model

The general form of the theoretical model is the following system of equations (Yotov et al, 2016 p.74), with time subscripts ignored for simplicity[14]:

$$X_{ij} = \frac{Y_i E_j}{Y}\left(\frac{t_{ij}}{\Pi_i \mathrm{P}_j}\right)^{1-\sigma}$$

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{\mathrm{P}_j}\right)^{1-\sigma}\left(\frac{E_j}{Y}\right)$$

$$\mathrm{P}_j^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma}\left(\frac{Y_i}{Y}\right)$$

$$p_i = \left(\frac{Y_i}{Y}\right)^{\frac{1}{1-\sigma}}\left(\frac{1}{\alpha_i \Pi_i}\right)$$

$$E_i = \phi_i Y_i = \phi_i p_i Q_i$$

The first line of the model defines the core of the empirical model:

- X_{ij} is trade between an origin i and destination j.
- The origin country's production is Y_i.
- The destination country's expenditure is E_j.
- Global production is $Y = \sum_i Y_i$.
- Trade costs comprise:
  - bilateral trade costs t_{ij}
  - multilateral export costs Π_i, also known as outward multilateral resistance
  - multilateral import costs P_{ijt}, also known as inward multilateral resistance.
- The trade cost elasticity is σ.

The second and third lines of the model define the multilateral resistance terms.

The fourth equation in the system defines producers' factory gate prices.

The fifth equation follows from assuming that trade balances are exogenous according to an exogenous parameter ϕ, closing the system.

[14] The derivation of this model begins from micro foundations. Costinot and Rodríguez-Clare (2014) provide a good overview of the micro foundations and assumptions of this and alternative models.

The next two subsections set out the empirical model.

General form of the empirical model

The general form of the empirical model is:

$$X_{ijt} = \exp\left(\eta_{it} + \psi_{jt} + t_{ij}^{1-\sigma}\right) . \epsilon_{ijt}$$

$$t_{ijt}^{1-\sigma} = \sum_{L} \beta_{rL} . R_{rL} + \delta_{ct} . C_{ct}$$

$$X_{ijt} = \exp\left(\eta_{it} + \psi_{jt} + \gamma_{ij} + \sum_{L} \beta_{rL} . R_{rL} + \delta_{ct} . C_{ct}\right) + \epsilon_{ijt}$$

The model estimates the value of trade flows (X_{ijt}) from a country, origin i, to a country, destination j, by year (t, for time) based on:

- output effects, labelled η_{it}, that capture average output in a country in each year, averaged over output for domestic trade and for exports by destination, so reflect variations in production conditions at the origin of trade
- demand effects, labelled ψ_{jt}, that capture average annual expenditure in a country in each year, averaged over expenditure on domestically produced products and imports by origin, so reflect variations in demand conditions at the destination of trade
- propensities to trade between pairs of countries (accounting for frictions such as distance) over all years captured in the variable labelled γ_{ij}, where domestic trade $\gamma_{ij=i}$ is typically the reference level (0) for this variable
- a matrix (R_{rL}) of rules and policies (r) affecting trade costs over time, with their effects captured by $\beta_{rL}$and L representing a lag structure over the timing of effects of policies – the conceptual basis for those lags is discussed further below while discussing the empirical specification of dynamics
- a matrix (C_{ct}) of other controls on trade costs and associated effects (δ_{ct})

Empirical specification

Specification of bilateral trade costs

Bilateral trade costs are estimated using directional-pair fixed effects (γ_{ij}). Directional-pair fixed effects are pair fixed effects accounting for origin-destination flows e.g. Canada to United States would be one fixed effect and United States to Canada the other fixed effects. This specification allows for asymmetric trade costs, potentially important where, for example, there are substantial otherwise unobserved persistent institutional effects which make trade flow more freely in one direction than another (Beverelli, et al, 2018).

Directional-pair fixed effects provide estimates of bilateral trade costs that do not vary over time and will estimate the effects of all sources of time invariant trade costs such as distance, size, border effects, social and cultural differences etc.

Policy effects on bilateral trade costs

The effects of policies on bilateral trade costs are picked up as deviations from fixed (effect) bilateral trade costs over time.

If bilateral trade costs are measured using fixed effects or other effects (variables) that do not change over time, then policy variables must vary over time. That is, one can only pick up the effects of changes to policies over time.

Identifying the effects of MFN policies, including domestic support, requires data on domestic trade (Heid et al, 2021). Thus, the model includes estimates of domestic trade flows and policy effects on trade are measured relative to domestic effects.

Proxies for multilateral trade resistance

The country-year fixed effects provide the means for estimating the multilateral trade resistance terms for the structural gravity model.

That said, the multilateral resistance terms can only ever be identified as an index relative to something because as an aggregate of bilateral trade costs they cannot (all) be identified directly separately from the bilateral trade costs. We measure the inward and outward multilateral resistances relative to the United States inward multilateral resistance (set to 1).

Model dynamics

The dynamic specification of the model – to account for lags in policy effects on trade - has been informed mainly by theoretical and conceptual considerations and findings in the literature.

Empirical constraints also limit dynamic specifications. These empirical constraints are:

- collinearity, where variable containing the same statistical information, often because they are conceptually related
- the length of the time series in the panel data set, which limits the number of lags that is possible without losing significant numbers of observations of trade flows.

The maximum number of lags has been limited to 3 years. This has been informed by the common use of time intervals of 3 years between observations in panel data analysis of gravity models (Yotov et al, 2016). It has also been informed by the relatively short time period covered by our data set. Where other studies use longer lags, they typically have decades of trade data in their data sets, while the data set used here contains only 10 year's worth of data and thus only 7 years of data after allowing for lags of up to 3 years.

Our empirical model allows for inclusion of consecutive years of data due to the informational value of including additional observations (Egger et al 2021). This differs from many other studies where only every third or fourth or fifth year of data.

Subsidies measures enter the model with only export (origin) effects.

The model allows for a term describing the effect of EU dairy quotas on EU trade with the rest of the world.[15] This variable was included because quotas had a material effect on EU dairy production and global supply response (Jongeneel and Gonzalez-Martinez, 2022).

The impact of the EU milk quotas is, in principle, ambiguous as far as EU exports of manufactured dairy products are concerned. The local effects of the quotas was to reduce milk production and restrict supply of manufactured products for export.

Regional trade agreement effects are admitted with a contemporaneous effect and a 3-year lag. The short-term effects of RTAs on trade are assumed to be captured in the tariff variable. And while the lagged tariff level will also capture some of the lagged effect of RTAs, the inclusion of the lagged RTA variables is there to capture any additional effects from RTAs above and beyond those that would be explained by changes in tariff rates. The literature on effects of RTAs indicate that such effects do exist (Baier et al, 2018), albeit with a lag of three to five years (Egger et al, 2021).

Estimating the multiplicative model

The method for estimating the structural gravity model is a mixture of passion and quasi-poisson GLM. Model testing suggests that the differences in parameter values and model fit, between a poisson GLM and a quasi-poisson are negligible and there are instances where the additional complication of quasi-poisson makes it unusable (principally in policy variable selection).

The estimation follows 4 steps:

1) a preliminary estimation for selection of trade cost variables and estimated effects of trade policies, using our full panel
    a) using a penalised (relaxed lasso) poisson GLM (Breinlich et al, 2021) on the full "saturated" model, with:
        i) penalty weight selected via cross validation on the model after removal of fixed effects
        ii) iteratively re-weighted least squares, used to estimate policy effects while controlling for fixed effects
    b) the estimated policy effects are then used as an offset in the next step
2) we estimate origin-year, destination-year and directional pair fixed effects, using PPML , with the trade policy offset (trade costs) from 1)

[15] The variable is a binary variable equal to 1 in those years in which EU dairy quotas were in operation. In our data set that is the years 2010 to 2015.

3) form a single year's baseline model in which we estimate directional pair trade costs for countries with zero trade, using conventional gravity variables to explain our estimated directional pair fixed effects and thus predict those costs for countries without trade flows

4) calibration (estibration) to make predicted trade match actual trade, by adding model residuals back into the model as unobserved trade costs and re-estimating origin and destination fixed effects conditional on trade costs (Anderson et al, 2018).

Policy Coefficients

The tables below present the estimated policy effects (coefficients) along with alternative (sensitivity) values from alternative model specifications. Table 7 presents the penalised model coefficients in the relaxed lasso model for ten different values of the penalty parameter, with the penalty doubling at each step. The first column of coefficient values is the penalty that minimizes the model mean-squared error. Missing values (denoted --) are variables deselected by the model.

Variables are:

- crop-specific subsidies (CRP),
- decoupled income support (DCP)
- rural development spending (DEV)
- dairy-specific payments (DRY)
- investment subsidies (INV)
- livestock-specific subsidies (LIV)
- payments for inputs and other factors of production (OTH)
- tariffs (Tariff)
- EU milk quotas (EUQ)
- regional trade agreements (RTA)
- total amber box support potentially available to dairy farm production outside the EU (TAR)
- blue box support available to dairy farm production outside the EU (TBR)
- green-box support potentially available to dairy farm production outside the EU.

The suffixes L1, L2, and L3 denote policy variables lagged 1, 2, or 3 years respectively. The EU suffixes on the policy variables denote policy effects applying only to intra-EU trade.

Table 8 presents comparisons of the penalised and unpenalized values for the policy coefficients for the variables selected by the first 3 values of the coefficient penalty. It also shows the standard errors for the unpenalized coefficients.

Table 9 presents average effect sizes for EU subsidies over the period 2013 to 2019 under different model specifications and in terms of tariff equivalents (percentages). It also shows ranges for policy effect sizes over that period (min, max).

Note that the ranges Table 9 reflect differing levels of support by EU member state and also different rates of change in subsidies over time. With lags included in the model, policies are often estimated to have short term effects that differ from long term effects. In some cases this will flow through into a, for example, cost increasing and trade reducing effect when the policy overall is expected to have a cost decreasing (subsidy) and trade increasing effect. For example, coupled support may be increased in response to negative shocks to production, and so the contemporaneous effect of that shock is estimated as being positive. That short term positive effect can dominate if the increase is large enough and if the increase is in the latter years of the sample (e.g. 2019).

TABLE 7: COEFFICIENTS ON POLICY VARIABLES FROM PENALISED REGRESSION MODEL BY VALUE OF COEFFICIENT PENALTY

	Coefficient penalty									
Variable	0.00077	0.00154	0.00230	0.00307	0.00384	0.00461	0.00538	0.00614	0.00691	0.00768
CRP	0.00644	0.00248	--	--	--	--	--	--	--	--
CRP_EU	-0.01177	-0.00496	--	--	--	--	--	--	--	--
CRP_EU_L2	-0.00032	--	--	--	--	--	--	--	--	--
CRP_L1	0.00530	0.00436	0.00287	0.00194	0.00142	0.00078	0.00004	--	--	--
CRP_L2	--	--	0.00022	0.00078	0.00124	0.00110	0.00063	--	--	--
CRP_L3	0.01003	0.00784	0.00670	0.00543	0.00423	0.00319	0.00236	0.00146	0.00033	--
DCP	-0.00214	-0.00166	-0.00099	-0.00070	-0.00047	-0.00020	--	--	--	--
DCP_EU	-0.00018	--	--	--	--	--	--	--	--	--
DCP_EU_L1	0.00019	--	0.00002	--	--	--	--	--	--	--
DCP_EU_L2	0.00029	--	--	--	--	--	--	--	--	--
DCP_EU_L3	0.00095	0.00141	0.00120	0.00111	0.00096	0.00080	0.00064	0.00055	0.00040	0.00020
DCP_L1	0.00090	0.00060	--	--	--	--	--	--	--	--
DCP_L3	0.00174	0.00121	0.00125	0.00093	0.00069	0.00037	0.00016	0.00004	--	--
DEV_EU	-0.00105	-0.00074	-0.00053	-0.00018	--	--	--	--	--	--
DEV_EU_L1	0.00016	--	--	--	--	--	--	--	--	--
DEV_EU_L3	0.00103	0.00015	--	--	--	--	--	--	--	--
DEV_L1	0.00141	0.00133	0.00106	0.00056	0.00008	--	--	--	--	--
DEV_L2	-0.00134	-0.00107	-0.00078	-0.00038	--	--	--	--	--	--
DEV_L3	-0.00232	-0.00138	-0.00110	-0.00080	-0.00050	-0.00010	--	--	--	--
DRY	0.00166	0.00201	0.00213	0.00217	0.00212	0.00220	0.00228	0.00226	0.00225	0.00224
DRY_EU	0.00185	0.00132	0.00122	0.00117	0.00110	0.00104	0.00097	0.00091	0.00082	0.00073
DRY_EU_L1	0.00031	0.00051	0.00037	0.00028	0.00021	0.00014	0.00004	--	--	--
DRY_EU_L2	0.00115	--	--	--	--	--	--	--	--	--

	Coefficient penalty									
Variable	0.00077	0.00154	0.00230	0.00307	0.00384	0.00461	0.00538	0.00614	0.00691	0.00768
DRY_EU_L3	0.00013	0.00000	--	--	--	--	--	--	--	--
DRY_L1	0.00054	0.00022	0.00007	0.00014	0.00024	0.00033	0.00037	0.00030	0.00020	0.00010
DRY_L2	-0.00185	-0.00051	-0.00008	--	--	--	--	--	--	--
EUQ	-0.04665	-0.04826	-0.04851	-0.04502	-0.04424	-0.03712	-0.03143	-0.02432	-0.01733	-0.01016
INV	-0.00103	-0.00020	--	--	--	--	--	--	--	--
INV_EU	0.00076	0.00026	0.00007	--	--	--	--	--	--	--
INV_EU_L1	0.00136	0.00043	--	--	--	--	--	--	--	--
INV_L1	-0.00168	-0.00075	-0.00010	--	--	--	--	--	--	--
INV_L3	-0.00224	-0.00180	-0.00141	-0.00112	-0.00085	-0.00073	-0.00064	-0.00050	-0.00036	-0.00020
LIV	-0.00049	--	--	--	--	--	--	--	--	--
LIV_EU	0.00206	0.00127	0.00082	0.00062	0.00043	0.00039	0.00031	0.00014	--	--
LIV_EU_L1	0.00066	0.00064	0.00076	0.00092	0.00108	0.00114	0.00119	0.00124	0.00125	0.00119
LIV_EU_L2	--	--	--	--	--	0.00010	0.00020	0.00018	0.00020	0.00016
LIV_EU_L3	0.00204	0.00111	0.00080	0.00071	0.00064	0.00051	0.00034	0.00019	0.00005	--
LIV_L3	0.00024	0.00103	0.00106	0.00098	0.00087	0.00081	0.00071	0.00052	0.00030	--
OTH	0.00165	0.00158	0.00150	0.00129	0.00103	0.00073	0.00041	0.00008	--	--
OTH_EU_L1	-0.00039	--	--	--	--	--	--	--	--	--
OTH_EU_L3	--	-0.00051	-0.00069	-0.00055	-0.00036	-0.00018	-0.00003	--	--	--
OTH_L1	0.00152	0.00073	0.00040	0.00012	--	--	--	--	--	--
OTH_L2	-0.00019	--	--	--	--	--	--	--	--	--
OTH_L3	-0.00097	-0.00041	-0.00007	--	--	--	--	--	--	--
RTA	0.04811	0.04288	0.03595	0.02895	0.02071	0.01106	0.00146	--	--	--
RTA_L1	0.23477	0.20598	0.18021	0.15098	0.12033	0.08980	0.05908	0.02355	--	--
RTA_L3	-0.45569	-0.40671	-0.36334	-0.31618	-0.26818	-0.22028	-0.17277	-0.12382	-0.08010	-0.04637

	Coefficient penalty									
Variable	0.00077	0.00154	0.00230	0.00307	0.00384	0.00461	0.00538	0.00614	0.00691	0.00768
TAR	0.08798	--	--	--	--	--	--	--	--	--
TAR_L2	0.51165	0.57204	0.34025	0.05567	--	--	--	--	--	--
TAR_L3	--	0.09572	0.13405	--	--	--	--	--	--	--
Tariff	0.04833	--	--	--	--	--	--	--	--	--
Tariff_L1	-0.25032	-0.15977	-0.08730	-0.02474	--	--	--	--	--	--
Tariff_L2	-0.02075	--	--	--	--	--	--	--	--	--
TBR	6.72848	6.30932	5.84402	5.41685	4.32620	3.26576	2.18691	1.17182	0.15662	--
TBR_L2	0.03516	0.26813	0.19042	--	--	--	--	--	--	--
TBR_L3	1.79006	0.82808	--	--	--	--	--	--	--	--
TGR	-0.51650	--	--	--	--	--	--	--	--	--
TGR_L1	-1.18652	-0.58901	-0.07739	--	--	--	--	--	--	--
TGR_L2	-1.01945	-0.46254	--	--	--	--	--	--	--	--

TABLE 8: PENALISED AND UNPENALISED COEFFICIENTS

	Coefficient penalty = 0.00077			Coefficient penalty = 0.00154			Coefficient penalty = 0.00230		
Variable	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error
CRP	0.00644	0.01024	0.20759	0.00248	0.00917	0.15749	--	--	--
CRP_EU	-0.01177	-0.01755	0.20215	-0.00496	-0.01674	0.06706	--	--	--
CRP_EU_L2	-0.00032	-0.00424	0.19605	--	--	--	--	--	--
CRP_L1	0.00530	0.00736	0.06789	0.00436	0.00490	0.08262	0.00287	0.00790	0.15893
CRP_L2	--	--	--	--	--	--	0.00022	-0.00325	0.06885
CRP_L3	0.01003	0.01319	0.08304	0.00784	0.01113	0.09446	0.00670	0.01059	0.08443

	Coefficient penalty = 0.00077			Coefficient penalty = 0.00154			Coefficient penalty = 0.00230		
Variable	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error
DCP	-0.00214	-0.00293	0.09530	-0.00166	-0.00292	0.02311	-0.00099	-0.00237	0.09526
DCP_EU	-0.00018	-0.00018	0.02391	--	--	--	--	--	--
DCP_EU_L1	0.00019	0.00030	0.00126	--	--	--	0.00002	0.00095	0.02405
DCP_EU_L2	0.00029	0.00056	0.00086	--	--	--	--	--	--
DCP_EU_L3	0.00095	0.00046	0.00097	0.00141	0.00126	0.00126	0.00120	0.00080	0.00042
DCP_L1	0.00090	0.00131	0.00212	0.00060	0.00168	0.00047	--	--	--
DCP_L3	0.00174	0.00240	0.00574	0.00121	0.00176	0.00106	0.00125	0.00238	0.00096
DEV_EU	-0.00105	-0.00134	0.00075	-0.00074	-0.00139	0.00585	-0.00053	-0.00147	0.00076
DEV_EU_L1	0.00016	0.00072	0.00129	--	--	--	--	--	--
DEV_EU_L3	0.00103	0.00174	0.00111	0.00015	0.00181	0.00075	--	--	--
DEV_L1	0.00141	0.00131	0.00074	0.00133	0.00181	0.00131	0.00106	0.00230	0.00066
DEV_L2	-0.00134	-0.00164	0.00116	-0.00107	-0.00159	0.00066	-0.00078	-0.00173	0.00073
DEV_L3	-0.00232	-0.00326	0.00343	-0.00138	-0.00327	0.00047	-0.00110	-0.00189	0.00101
DRY	0.00166	0.00141	0.00118	0.00201	0.00217	0.00111	0.00213	0.00163	0.00370
DRY_EU	0.00185	0.00230	0.00070	0.00132	0.00150	0.00334	0.00122	0.00146	0.00078
DRY_EU_L1	0.00031	0.00028	0.00082	0.00051	0.00105	0.00076	0.00037	0.00090	0.00072
DRY_EU_L2	0.00115	0.00227	0.00058	--	--	--	--	--	--
DRY_EU_L3	0.00013	0.00020	0.00064	0.00000	0.00077	0.00070	--	--	--
DRY_L1	0.00054	0.00063	0.00101	0.00022	0.00007	0.00048	0.00007	0.00047	0.00045
DRY_L2	-0.00185	-0.00319	0.00079	-0.00051	-0.00156	0.00063	-0.00008	-0.00147	0.00276
EUQ	-0.04665	-0.04735	0.00145	-0.04826	-0.03696	0.00104	-0.04851	-0.05666	0.00063
INV	-0.00103	-0.00201	0.00329	-0.00020	-0.00198	0.00073	--	--	--
INV_EU	0.00076	0.00139	0.00065	0.00026	0.00116	0.00144	0.00007	0.00061	0.00072
INV_EU_L1	0.00136	0.00216	0.00130	0.00043	0.00162	0.00294	--	--	--

	Coefficient penalty = 0.00077			Coefficient penalty = 0.00154			Coefficient penalty = 0.00230		
Variable	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error
INV_L1	-0.00168	-0.00252	0.00066	-0.00075	-0.00199	0.00117	-0.00010	-0.00143	0.00075
INV_L3	-0.00224	-0.00265	0.00088	-0.00180	-0.00285	0.00129	-0.00141	-0.00244	0.00149
LIV	-0.00049	-0.00198	0.00102	--	--	--	--	--	--
LIV_EU	0.00206	0.00330	0.00226	0.00127	0.00231	0.00075	0.00082	0.00165	0.00298
LIV_EU_L1	0.00066	0.00067	0.00640	0.00064	0.00057	0.00111	0.00076	0.00039	0.00117
LIV_EU_L2	--	--	--	--	--	--	--	--	--
LIV_EU_L3	0.00204	0.00266	0.00131	0.00111	0.00224	0.00104	0.00080	0.00159	0.00070
LIV_L3	0.00024	-0.00027	0.00108	0.00103	0.00033	0.00674	0.00106	0.00074	0.00082
OTH	0.00165	0.00164	0.00081	0.00158	0.00183	0.00131	0.00150	0.00178	0.00102
OTH_EU_L1	-0.00039	-0.00129	0.00121	--	--	--	--	--	--
OTH_EU_L3	--	--	--	-0.00051	0.00004	0.00114	-0.00069	-0.00062	0.00106
OTH_L1	0.00152	0.00264	0.00086	0.00073	0.00165	0.00080	0.00040	0.00122	0.00050
OTH_L2	-0.00019	-0.00052	0.00118	--	--	--	--	--	--
OTH_L3	-0.00097	-0.00113	0.00084	-0.00041	-0.00126	0.00099	-0.00007	-0.00090	0.00105
RTA	0.04811	0.05308	0.00084	0.04288	0.05637	0.00074	0.03595	0.05505	0.00080
RTA_L1	0.23477	0.27201	0.00354	0.20598	0.25817	0.00048	0.18021	0.26680	0.00082
RTA_L3	-0.45569	-0.50854	0.00097	-0.40671	-0.49946	0.00147	-0.36334	-0.49896	0.00154
TAR	0.08798	0.93757	0.00095	--	--	--	--	--	--
TAR_L2	0.51165	0.26598	0.00050	0.57204	1.03840	0.00124	0.34025	0.82873	0.00123
TAR_L3	--	--	--	0.09572	-0.64019	1.87609	0.13405	0.73866	1.73593
Tariff	0.04833	0.27021	0.00146	--	--	--	--	--	--
Tariff_L1	-0.25032	-0.40401	1.54900	-0.15977	-0.30087	1.12358	-0.08730	-0.28872	1.17428
Tariff_L2	-0.02075	-0.03127	1.10677	--	--	--	--	--	--
TBR	6.72848	6.58854	2.11609	6.30932	8.21129	1.56156	5.84402	6.74515	0.88396

	Coefficient penalty = 0.00077			Coefficient penalty = 0.00154			Coefficient penalty = 0.00230		
Variable	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error	Penalised	Unpenalised	Std error
TBR_L2	0.03516	-0.17203	1.22770	0.26813	0.04646	1.06956	0.19042	1.39300	1.69595
TBR_L3	1.79006	2.77166	1.25722	0.82808	3.88362	2.14271	--	--	--
TGR	-0.51650	-1.35664	0.91507	--	--	--	--	--	--
TGR_L1	-1.18652	-2.07943	2.17806	-0.58901	-1.53353	1.33953	-0.07739	-1.87136	0.94772
TGR_L2	-1.01945	-1.47920	2.63503	-0.46254	-2.03320	2.94818	--	--	--

TABLE 9: RANGES FOR EFFECTS OF EU SUBSIDIES IN TARIFF EQUIVALENTS

Average percentage tariff equivalent (2013-2019), with minimum and maximum values in brackets.

		Coefficient penalty = 0.00077		Coefficient penalty = 0.00154		Coefficient penalty = 0.00230	
Area	Support	Penalised	Unpenalised	Penalised	Unpenalised	Penalised	Unpenalised
EU	Crop-specific	-1.4 (-11.3 , 0.0)	-2.0 (-15.5 , 0.0)	-1.0 (-7.9 , 0.0)	-1.7 (-12.9 , 0.0)	-0.6 (-5.4 , 0.0)	-1.0 (-8.3 , 0.1)
	Decoupled income support	-2.2 (-5.8 , 4.2)	-3.3 (-8.5 , 5.6)	-0.7 (-2.8 , 3.8)	-2.3 (-6.3 , 5.2)	-1.2 (-3.2 , 2.8)	-0.2 (-3.1 , 8.1)
	Rural development	4.3 (-0.2 , 23.4)	7.0 (-0.1 , 39.1)	2.1 (-0.3 , 11.1)	5.9 (-0.2 , 32.7)	1.5 (-0.3 , 8.0)	2.5 (-0.7 , 13.4)
	Dairy-specific	-0.7 (-3.8 , 2.0)	0.9 (-2.6 , 10.1)	-2.0 (-12.1 , 1.1)	-1.0 (-5.4 , 1.7)	-2.4 (-14.7 , 1.2)	-0.9 (-5.0 , 1.4)
	Investment	2.9 (0.0 , 12.7)	4.4 (0.0 , 20.4)	1.6 (0.0 , 6.1)	4.1 (0.0 , 18.9)	0.8 (0.0 , 3.4)	2.2 (0.0 , 8.5)
	Livestock-specific	0.1 (-0.2 , 0.5)	0.5 (0.0 , 3.0)	-0.2 (-1.2 , 0.0)	-0.1 (-0.4 , 0.0)	-0.2 (-1.2 , 0.0)	-0.2 (-0.9 , 0.0)
	Inputs and other	-1.3 (-7.1 , 0.6)	-1.6 (-9.2 , 0.9)	-1.2 (-6.3 , 0.2)	-1.4 (-7.9 , 0.7)	-1.2 (-5.8 , 0.0)	-1.3 (-7.2 , 0.5)

		Coefficient penalty = 0.00077		Coefficient penalty = 0.00154		Coefficient penalty = 0.00230	
Area	Support	Penalised	Unpenalised	Penalised	Unpenalised	Penalised	Unpenalised
IntraEU	Crop-specific	-0.6 (-6.3 , 0.5)	-0.6 (-6.5 , 0.9)	-0.6 (-5.8 , 0.2)	-0.5 (-6.1 , 0.8)	-0.6 (-5.4 , 0.0)	-1.0 (-8.3 , 0.1)
	Decoupled income support	-7.1 (-15.1 , 3.8)	-7.8 (-16.6 , 4.7)	-6.3 (-13.5 , 3.2)	-7.2 (-15.5 , 4.6)	-6.1 (-12.7 , 2.5)	-7.1 (-15.3 , 4.4)
	Rural development	4.0 (0.0 , 20.9)	4.7 (0.0 , 24.6)	3.2 (0.0 , 16.6)	5.0 (0.0 , 26.4)	2.5 (0.0 , 13.0)	5.3 (0.0 , 28.4)
	Dairy-specific	-4.1 (-24.7 , 2.2)	-4.2 (-25.3 , 2.4)	-3.9 (-23.3 , 2.1)	-4.3 (-25.8 , 2.6)	-4.0 (-24.3 , 2.0)	-3.4 (-20.0 , 2.1)
	Investment	1.6 (0.0 , 6.3)	2.1 (0.0 , 8.3)	1.2 (0.0 , 4.6)	2.3 (0.0 , 9.4)	0.8 (0.0 , 3.2)	1.8 (-0.3 , 7.3)
	Livestock-specific	-1.0 (-4.5 , 0.0)	-1.0 (-4.3 , 0.0)	-0.9 (-4.0 , 0.0)	-1.2 (-5.5 , 0.0)	-0.8 (-3.4 , 0.0)	-1.0 (-4.4 , 0.0)
	Inputs and other	-1.0 (-5.9 , 0.7)	-0.8 (-5.3 , 1.0)	-0.9 (-5.1 , 0.6)	-1.4 (-8.0 , 0.7)	-0.7 (-4.2 , 0.6)	-0.9 (-5.9 , 1.2)

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