STAFF MEMO

How much of a tailwind have we had from the weaker krone?

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NORGES BANK

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NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

How much of a tailwind have we had from the weaker krone?[1]

Bjørn Naug and Einar W. Nordbø[2]

It is usual to assume that a weaker currency will stimulate exports and improve the balance of trade. Despite the krone's depreciation in recent years, however, exports have grown little and the non-oil trade deficit has widened. This raises questions about what effects the weaker krone has actually had. We find that exports would probably have been much lower without the depreciation of the krone. Our conclusion, therefore, is that there has been a significant tailwind.

The downturn in oil prices from autumn 2014 coincided with a marked improvement in Norwegian firms' cost competitiveness, thanks mainly to the krone depreciation. Expressed in a common currency, relative wage costs were 14% lower in 2017 than they were in 2013 (see Chart 1). This would usually be expected to contribute to increased economic activity, with both domestic and foreign customers shifting their demand towards Norwegian firms, thus improving the balance of trade. However, Norway's trade balance has moved in the opposite direction in recent years. Despite the krone depreciation, the non-oil trade deficit has widened (see Chart 1).

Chart 1 Non-oil trade deficit and relative wage costs in manufacturing in a common currency
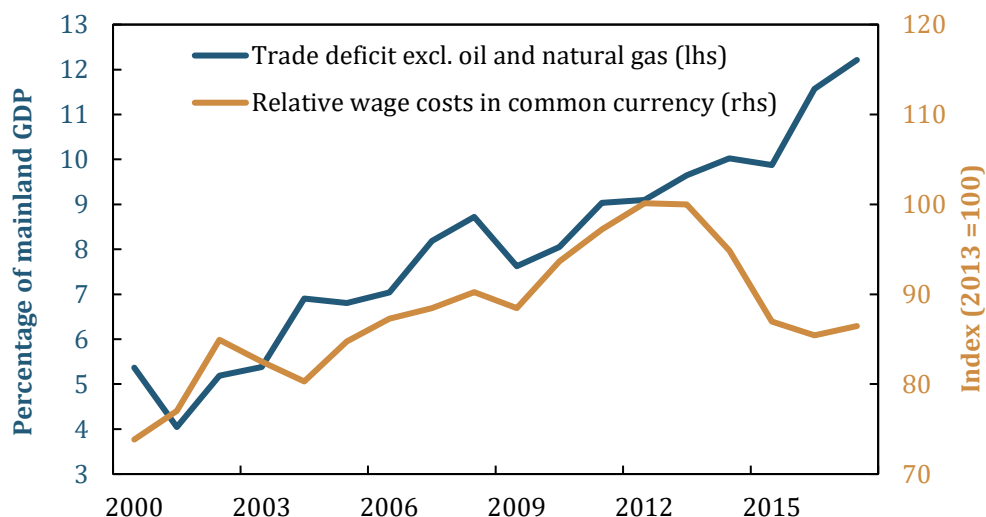
Source: Statistics Norway and Norwegian Technical Calculation Committee for Wage Settlements (TBU)

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[1] This is a translation of a text originally presented as two blog posts in Norwegian on Bankplassen.no, https://bankplassen.norges-bank.no/. The first can be found here and the second here.
[2] This staff memo should not be reported as representing the views of Norges Bank. The views expressed are those of the authors and do not necessarily reflect those of Norges Bank.

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

This raises questions about whether the weaker krone has provided as great a stimulus as might have been expected. International studies have suggested that the importance of exchange rates for foreign trade may have decreased in recent years, see for example Ahmed et al. (2015) and Ollivaud et al. (2015). This is attributed partly to the emergence of *global value chains*, where production processes increasingly cross national borders. Firms are also specialising in different stages of production rather than producing finished goods from scratch.
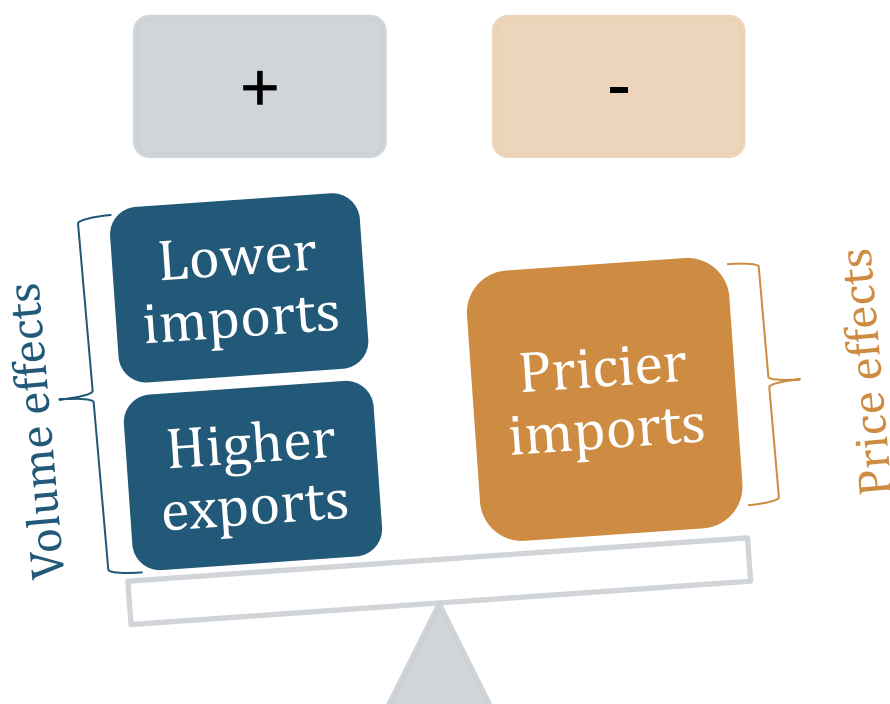
In Part 1 of this Staff Memo, we run through standard textbook theory on how exchange rate movements affect foreign trade, before looking at factors that might lead actual developments to depart from this basic theory. With this in mind, Part 2 provides an overview of how exports have fared in recent years. Part 3 discusses whether exports during the period have been in line with empirical models that include the krone exchange rate and other drivers, while Part 4 does the same for imports. Finally, in Part 5, we explore the case for the krone exchange rate having become less important over time.

1. Why should a weaker currency boost the balance of trade?

When discussing the impact of the exchange rate on trade with other countries, it can be useful to differentiate between the effects on *export and import prices* and the effects on *export and import volumes*.

Textbook theory builds on all export prices staying the same in the exporting country's currency when the exchange rate changes. Measured in Norwegian kroner, therefore, it is assumed that prices for the goods and services we sell abroad will not change when the krone drops in value, while import prices will rise by the same percentage as the krone falls. In isolation, pricier imports will reduce the balance of trade (see Chart 2). The assumption that the trade balance will improve when the currency weakens is thus based on export and import volumes changing to an extent that more than offsets the negative price effect. The assumed volume effects are derived from classical theory on price and demand. Norwegian goods become cheaper abroad, which is expected to result in higher exports. Similarly, higher import prices mean that Norwegian firms and consumers buy less from abroad.

4

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

Chart 2 Effects of currency depreciation on the trade balance

If, as theory has it, a 10% krone depreciation increases import prices by 10%, it will be enough for the trade balance to improve if exports *rise* by more than 5% as long as imports *fall* by the same amount. This all assumes that foreign trade is in balance to begin with. In cases where the volume effects dominate, with the result that the net effect on the trade balance is positive, economists like to say that the Marshall-Lerner condition is met.

One obvious explanation for the trade balance not improving when the currency weakens might therefore be that export and import volumes are not that sensitive to exchange rate movements. In Norway, for example, imports of clothing, cars and household items may not be very price-sensitive, as these are largely "necessities" with little or no domestic production.

An alternative explanation might be that imports are much higher than exports to begin with. When the currency weakens, there will then be a bigger impact from imports becoming more expensive, and so the volume effects will need to be greater for the trade balance to improve. Excluding oil and gas, Norway imported almost 40% more than it exported in 2013.

A third explanation for the trade balance not improving when the currency weakens might be that foreign trade is also driven by factors other than relative prices, and that these factors together stimulate imports more than exports. Many of these factors will also impact on the

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

exchange rate, which means that it will often be difficult to isolate the effects of exchange rate movements.

These explanations all assume that the textbook theory is correct. In the following, we discuss possible weaknesses in the basic theory, and look at how exchange rate movements might affect the trade balance under alternative assumptions.
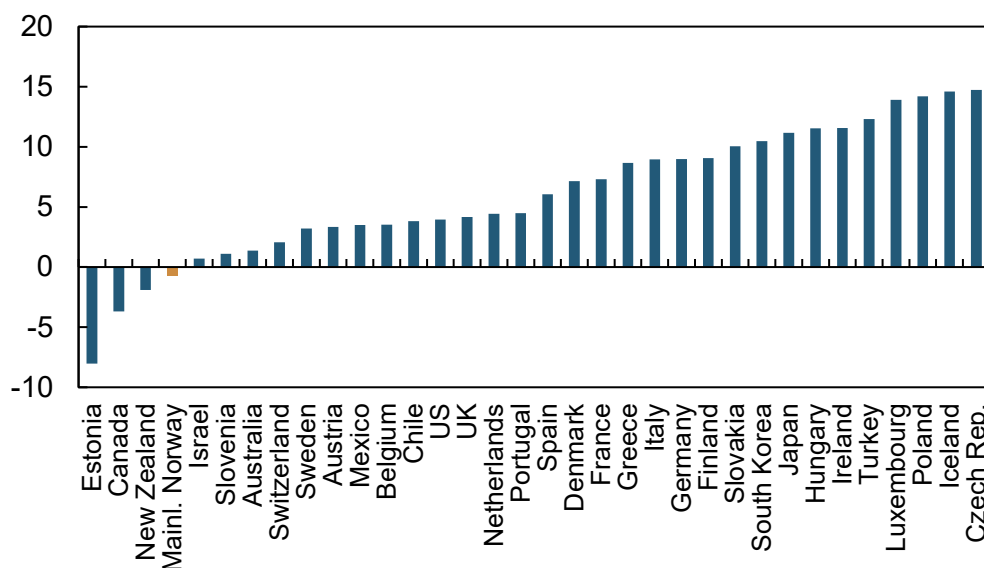
1.1. Incomplete pass-through to prices

The assumption that currency depreciation has no effect on export prices but a full pass-through to import prices finds little support in empirical studies. The pass-through to retail prices is lessened by transport costs, taxes and other costs in the importing country, but even allowing for this, it is generally found that import prices rise less far than the currency falls. At the same time, export prices typically rise slightly, see for example Burstein and Gopinath (2014).

One popular explanation is that some prices are set in the *importing country's currency* rather than that of the exporting country. If prices are also agreed for a set period, any price adjustments will be delayed until new contracts are signed.

Another hypothesis, which can also explain why the incomplete pass-through persists, is that firms do not charge the same prices in all markets, but take account of local market conditions when setting prices. *Firms' margins* will then vary from market to market. Krugman (1986) refers to this as *pricing to market*. When the exchange rate with another country falls, it may be that exporters seize the opportunity to increase their mark-up in that market.

Chart 3. Import content of exports. Change from 1997 to 2014. Percentage points

Source: OECD and Statistics Norway

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

A third explanation is that a weaker currency can also push up *exporters' costs*. This will apply particularly if exporters are making increasing use of suppliers in other countries, which is exactly what the emergence of global value chains has resulted in. According to the OECD, the import content of exports has increased in 30 out of 34 countries since the 1990s (see Chart 3).

It can be seen from the chart that Norway is one of the few countries where the import share of exports has not increased. Part of the explanation may be that these estimates are based on data in current prices, and that prices for value added in the mainland economy (ex oil and shipping) have risen faster than those for the imported inputs. Had these estimates been based on volume data, they would doubtless have shown a growing import share in Norway too. That said, it may also be that Norway's peripheral geographical location has resulted in cross-border production chains being less prevalent here than in small, open economies in Continental Europe.

Even when the pass-through from the exchange rate to prices is limited, it can still put a damper on the volume effects of currency movements. This is because it is actual selling prices that are the main determinant of demand. But an incomplete pass-through to prices is not necessarily a good explanation for the trade balance not improving when the currency depreciates. Taken together, a smaller rise in import prices and an increase in export prices mean that the aggregate price effect will not be as negative as suggested in Chart 2. Even if the volume effects of exchange rate movements are also weaker, the net impact on the trade balance can still be positive.

## 1.2. What if prices are set in the world market?

The above assumes that the goods that are exported differ to some extent from those produced in other countries, allowing exporters themselves to set the price. It also assumes that exporters have idle capacity, making it comparatively easy for them to satisfy any increase in demand.

With some goods, however, it may be more reasonable to assume that exporters' products are more or less identical to equivalent products abroad. The prices for these goods will therefore be set in the world market. This knocks out the traditional mechanism whereby exports increase because they become relatively cheaper abroad. A weaker currency can still stimulate exports, but rather than this being through an increase in demand, the mechanism now is that currency depreciation brings *higher export prices and better profitability*, which means that firms will want to produce more. Because many price takers will probably be operating close to capacity to begin with, however, it may take time for actual output to increase. This applies especially if there is a need for heavy investment to expand production capacity.

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

2. What are our exports and how have they fared recently?

In Norway's case, energy goods (mainly refined petroleum products), industrial raw materials and seafood are examples of goods where prices are determined largely by international conditions. As we will return to later, the production of these goods is also fairly capital-intensive. Taken together, these goods categories, shown in blue in Chart 4, accounted for more than a third of mainland exports in 2017. Goods and services where the oil service industry accounts for a substantial share of exports made up almost a further third. The final third of mainland exports consisted of tourism (defined as foreign visitors' consumption while in Norway), other goods and other services.

Chart 4. Composition of mainland exports in 2017. Percent
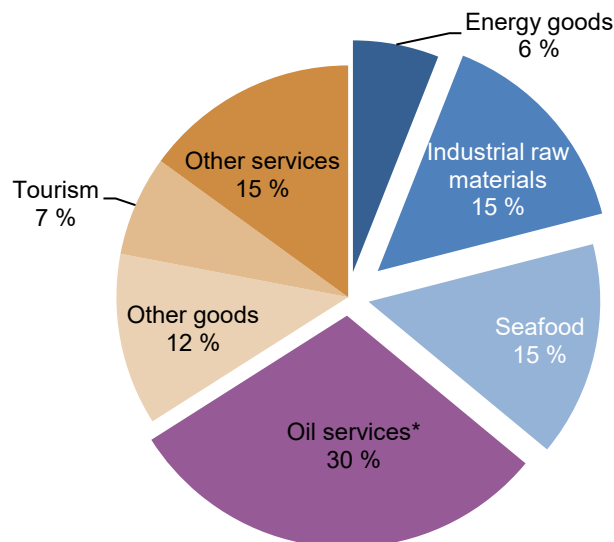
*Categories of goods and services in the national accounts where the oil service industry accounts for a substantial share of exports.

Source: Statistics Norway

In the period through to 2013, when wage growth was higher in Norway than among our trading partners and the krone was generally upward bound, mainland exports increased slightly more slowly than trading partners' imports. In the period since, mainland exports have grown much more slowly than trading partners' imports (see Chart 5). This has happened even though the krone's depreciation during the period should, in theory, have caused other countries to buy more from us.

It is easier to understand this apparent paradox if we look more closely at developments in the various subcategories. Much can be put down to exports from the oil service industry, which were pulled down by the sharp drop in global investment in offshore oil production, the Norwegian oil service industry's speciality. These exports were 7%

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

lower in 2017 than they were in 2013 (see Chart 6). There has also been only modest growth in exports of energy goods, seafood and basic materials since 2013, but, as suggested earlier, there is reason to expect supply-side factors to be as important for these goods as the krone exchange rate and international demand. Other exports have mirrored trading partner imports more closely. Tourism, for example, increased by more than 20% during the period.

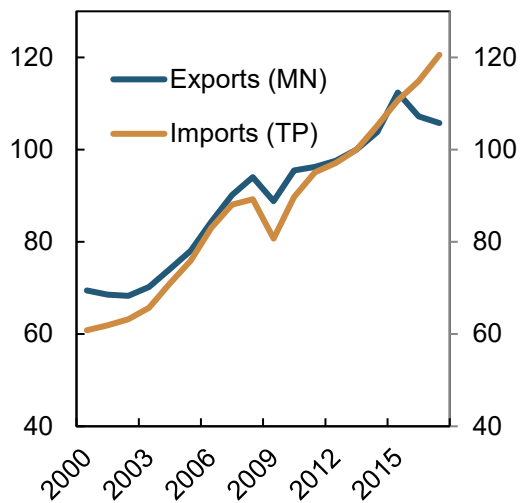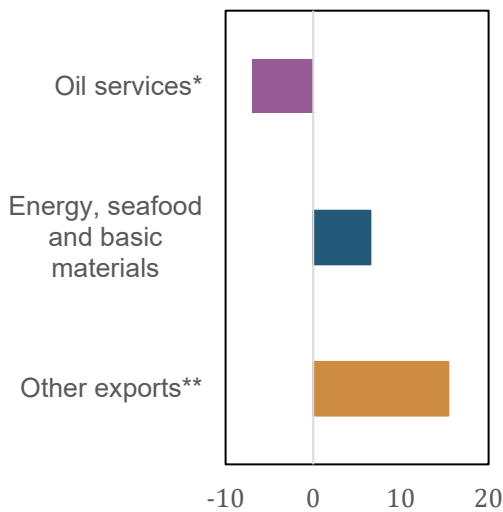Chart 5. Mainland exports and trading partner imports. Volumes. Index. 2013 = 100

Chart 6. Mainland exports by category. Change from 2013 to 2017. Volumes. Percent

*Categories of goods and services in the national accounts where the oil service industry accounts for a substantial share of exports.

**Excluding social and financial services.

Source: Statistics Norway

3. Can we explain how exports have moved?

We now continue our review of how exports have moved in recent years, but based on empirical models for exports. Using these models, we aim to answer two main questions:

1. Have exports since 2013, from before the sharp fall in the krone, been as we might have expected based on historical patterns?
2. How might exports have moved in a scenario where the other drivers have been the same, but there has been no real depreciation of the krone since 2013?

A country's exports are usually modelled as a function of GDP or trading partner imports and a measure of relative prices or costs. As

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

noted earlier, this approach is not well-suited to large parts of Norway's mainland exports. In the following, we therefore look instead at separate models for the different components of exports. These models are described in the appendix.

3.1. Exports from the oil service industry

The Norwegian oil service industry's exports increased substantially from 2005 until the first half of 2015, a period of strong growth in global offshore investment. These exports then fell steeply through to the end of 2017 as global offshore investment plunged. Our key trading partners' total imports do not therefore give a good picture of the actual demand situation for firms supplying oil production outside Norway. If we include a measure of global offshore investment in our estimation, however, we obtain a model that fits comparatively well. In fact, the oil supply industry's exports in 2017 are almost identical to the estimates from such a model (see Chart 7). We have estimated the model here on data up to and including 2013. The model projections after 2013 are based on actual values for the explanatory variables.

The estimates also indicate that the weaker krone has helped the oil service industry considerably. Without this depreciation, the model suggests that the industry's exports in 2017 would have been 9% lower than they actually were.

*Chart 7. Exports by category and model estimates (2014-2017). Volumes. Index (2013 = 100)*
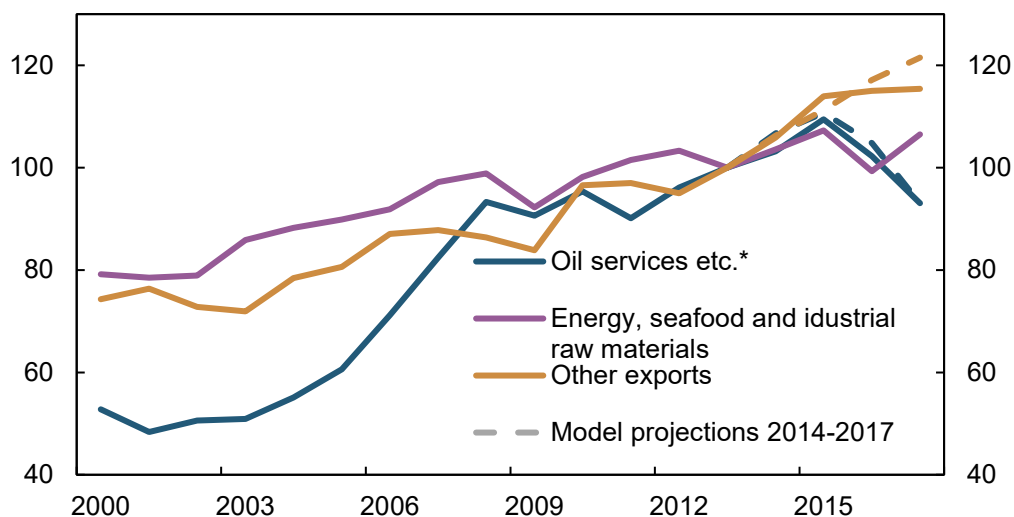
*Goods and services categories in the national accounts where the oil service industry accounts for a substantial share of exports.

Source: Statistics Norway and own calculations

3.2. Energy goods, seafood and industrial raw materials – capital-intensive price takers

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

Standard export models are not well-suited to explaining exports of energy goods, seafood and industrial raw materials. While the traditional models assume that exports will move with demand and relative prices, firms in these sectors will largely operate at or near capacity and with prices that are largely set in global markets. This is particularly the case where substantial assets are tied up in production facilities and machinery which often has no other real use. When it comes to oil refining, which accounts for almost all mainland exports of energy goods, fixed capital per employee amounted to more than NOK 6 million in 2017 (see Chart 8). In the metals industry, which dominates exports of industrial raw materials, there was fixed capital of NOK 4 million for every worker. Capital intensity in fisheries and aquaculture is also higher than elsewhere in industry.

Chart 8. Fixed capital per employee in selected industries in 2017. NOK million
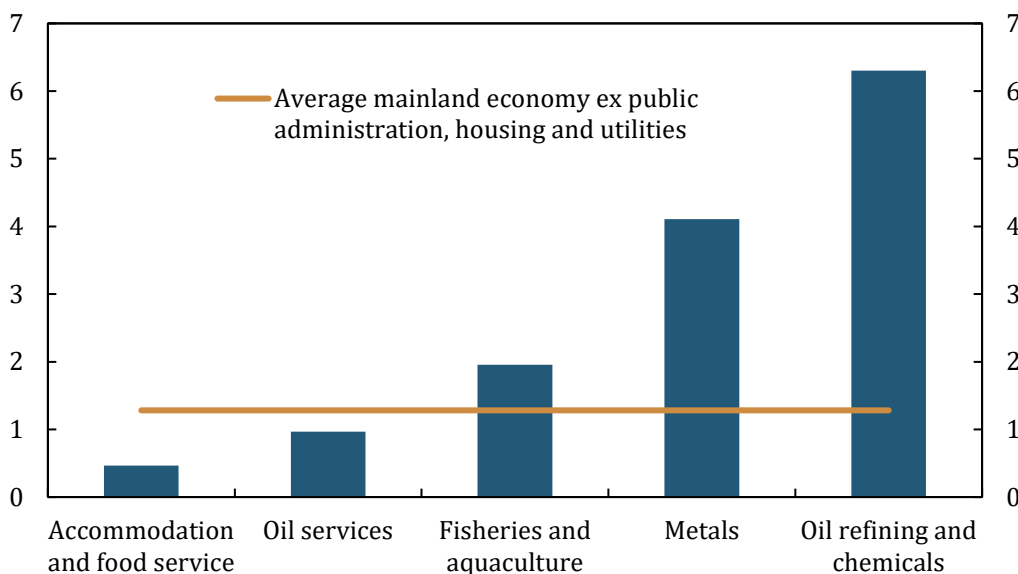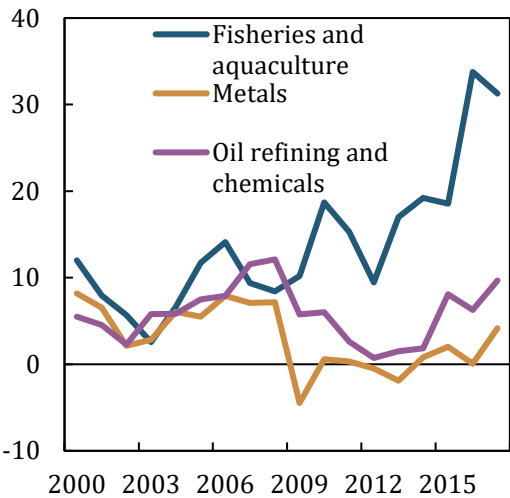

Source: Statistics Norway

In the short term, there is reason to expect a weaker krone to result mainly in higher export prices and better profitability in these industries. Chart 9 shows that profitability has indeed improved since 2013. Fisheries and aquaculture has led the way with an operation surplus of NOK 31 billion in 2017 according to the national accounts, almost twice that in 2013. Besides the weaker krone, this can be put down to higher salmon prices globally.

Exports of seafood and basic materials have been largely flat since 2013 in volume terms (see Chart 10). Problems with salmon lice have contributed to the stagnation in seafood. Between 2006 and 2012,

seafood exports grew by almost 60%. Exports of industrial raw materials have been fairly stable throughout the past decade. The seemingly weak growth in recent years needs to be seen in the light of the metals industry as a whole *losing money* in both 2012 and 2013 (see Chart 9), which would doubtless have led to more closures had it persisted. Nor, presumably, did we therefore see the full consequences of the krone's strong appreciation up until 2013 in the production data.

Chart 9. Operation surplus in selected industries. Billions of 2017-NOK (mainland GDP deflator)

Chart 10. Exports of selected goods. Volumes. Index (2013 = 100)

Source: Statistics Norway
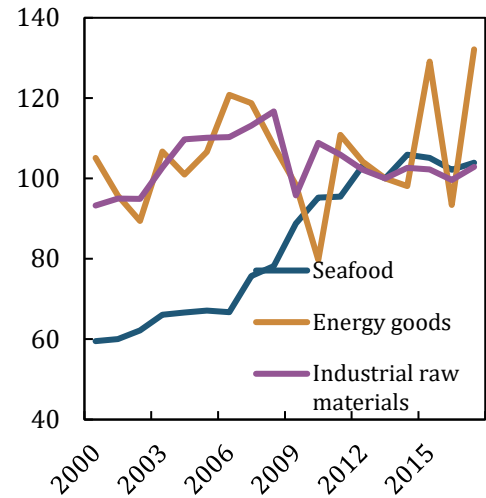
Source: Statistics Norway

Exports of energy goods were relatively strong in 2017 after low levels the previous year (see Chart 10). The substantial fluctuations from year to year have to do with almost all of these goods coming from the country's two oil refineries. Production problems at either therefore impact appreciably on exports.

There is no reason to believe that exports of energy goods, seafood and industrial raw materials are immune to movements in the krone and relative wage costs, but the relationships are probably not as close as for other goods. It will therefore also be difficult to capture these relationships in empirical models. We have not found any such relationships and so have no basis for drawing any conclusions about how these exports would have fared had the krone not weakened.

3.3. Other exports

Other exports from the mainland economy are explained relatively well by movements in relative costs and trading partners' total imports. The projections from empirical models that include these explanatory variables are quite close to actual exports up to and including 2016, but exports in 2017 were somewhat lower than projected (see Chart 7).

One possible explanation is that parts of these exports too are linked to oil production abroad.

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

The estimates nevertheless indicate that the weaker krone has been important for exports of these goods and services. According to our empirical models, other exports would have been 5% lower in 2017 without this depreciation.

# 4. Modest exchange rate effect on imports[3]

Import growth has slowed appreciably during the period with a weaker krone (see Chart 11). Imports have nevertheless continued to outgrow mainland exports since 2013, causing the trade deficit to widen further.

Chart 11. Imports and GDP. Average annual change. Percent. Volumes
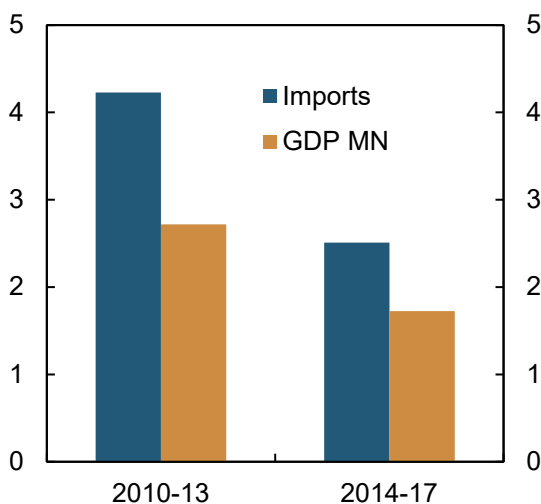
Chart 12. Imports and model estimates. Volumes. Index (2013 = 100)
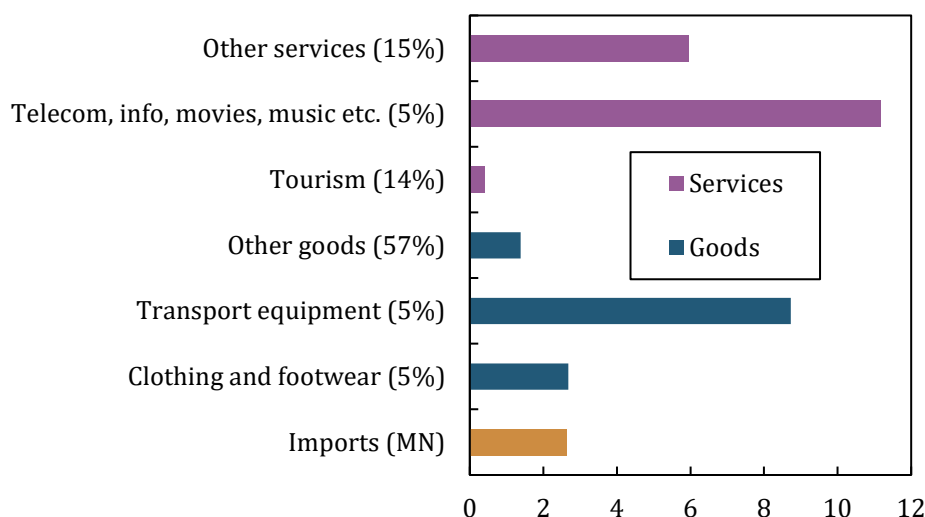
Source: Statistics Norway
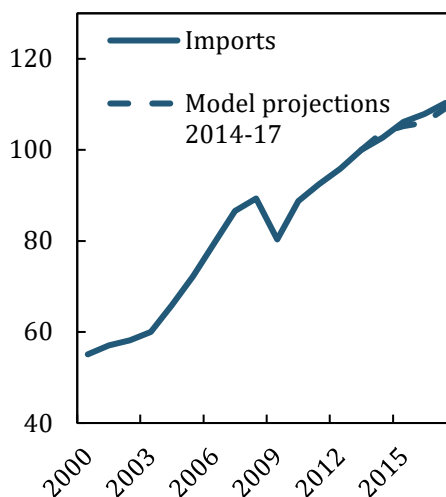
Source: Statistics Norway and own calculations

Imports were 10% higher in 2017 than in 2013, which is similar to the projection from an empirical model based on data up to and including 2013 (see Chart 12). According to the model, lower growth in activity is the most important reason for the slowdown in import growth. Another factor is weak growth in demand components with a high import content, such as oil investment and exports. The other explanatory variables in the model are an indicator that captures the general tendency towards specialisation in the OECD countries, and relative wage costs in a common currency. The estimated effects of movements in this last factor are fairly modest, however. According to the model, imports

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[3] Imports excluding oil, gas, aircraft, ships, oil platforms and shipping services.

would have been just 1% higher in 2017 without the decline in the krone since 2013.

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

Chart 13. Imports. Average annual growth 2014-2017. Volumes. Share of total imports in brackets

Source: Statistics Norway

Although the empirical model appears to fit fairly well with the figures for total imports, it is interesting to look more closely at developments in the various subcategories. Imports of goods have generally grown slowly since 2013, but transport equipment is a clear exception (see Chart 13). This can be attributed to the strong growth in sales of electric cars. The tax exemptions and other benefits associated with these vehicles seem to have more than offset the weaker krone in isolation pushing up their prices.

Imports of services have, on average, grown much faster than imports of goods since 2013. There has been a similar pattern in many other countries. One important explanation is that recent technological advances have particularly boosted trade in services. In Norway, this can be seen from the especially strong growth in imports of telecommunication and information services, movies and music – services that are increasingly being sold online. By way of comparison, tourism – Norwegians' consumption while physically abroad – has barely increased at all since 2013.

5. Has the krone exchange rate become less important?

With our estimates suggesting that the exchange rate has little impact on imports, we need to ask whether this is a recent phenomenon or a more permanent feature of the Norwegian economy. To attempt to

answer this, we have estimated the empirical equations we have developed over different time periods. Chart 14 presents the results of this exercise for both exports and imports. The chart shows the long-term impact of a 10% drop in relative wage costs expressed in a common currency. For exports, this is a weighted average of the models for the various subcategories.[4] We have also used an estimated model to calculate how far Norwegian import prices will rise after a 10% fall in the krone (see Chart 15).

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

Chart 14. Volume effect of 10% real krone depreciation. Absolute values. Percent
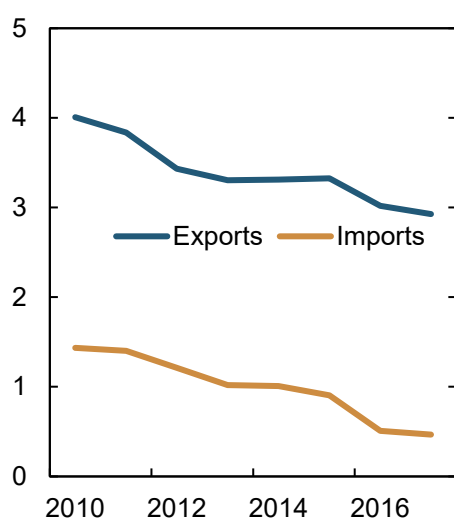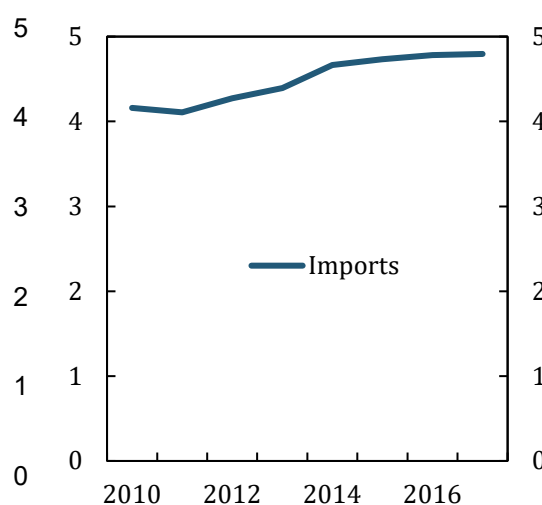
Chart 15. Price effect of 10% real krone depreciation. Percent

Based on data up to and including 2010, a 10% real fall in the krone exchange rate is estimated to increase exports by around 4%. When the models are estimated on data right through to 2017, this effect reduces to around 3%. The estimated volume effect has thus decreased slightly, but the change over this period is not that great given the uncertainty in the estimates. The decrease from 2013 to 2017 is just 0.4 percentage point.

There is a similar pattern with imports. Based on data up to and including 2010, a 10% depreciation reduces imports by 1-2%. The estimated effect then reduces to 0-1% when the model is based on data through to 2017. The change from 2013 to 2017 is 0.5 percentage point, which is far from statistically significant. At the same time, the estimated pass-through from the krone exchange rate to import prices is at least as strong as before. If imports have become less sensitive to movements in the krone, this does not seem to be a result of changes in the exchange rate having less of an impact on prices than before.

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[4] For the subcategories where we did not find empirical support for the krone exchange rate playing any role in export growth, the effect has been set equal to zero when calculating the weighted average. These categories are: energy goods, basic materials, seafood, financial services and social services. Exports of financial services fluctuate substantially from year to year and do not seem to be affected greatly by external demand and relative wage costs. Exports of social services are determined largely by how many asylum seekers there are in Norway.

The estimated exchange rate effects on Norwegian exports are largely in keeping with the results of international studies. On the other hand, the effects on imports are relatively small in comparison to other countries. For example, Bussière et al. (2017) find in a study of 51 countries that, on average, exports rise by 3-4% and imports fall by 2-3% following a 10% depreciation, but with considerable variations from country to country. In a similar study of 60 countries, the IMF (2015) concludes that exports rise by almost 2% and imports fall by about the same. The IMF study also concludes that these exchange rate effects have been fairly stable over time.

As we mentioned earlier, the Marshall-Lerner condition requires the impact on exports and imports to be at least 5% if the trade balance is to improve following a depreciation. The reported effects are smaller than this, but Bussière et al. (2017) nevertheless conclude that the Marshall-Lerner condition is met in all of the countries they look at. The explanation is that the pass-through from the exchange rate to prices is incomplete. The necessary volume effects are then also reduced.

One explanation for Norwegian imports not seeming to be affected greatly by movements in the krone may be that Norwegian firms have become increasingly specialised in the production of a small range of goods and services. This has meant that there are few domestic alternatives to many of the goods and services we import. At the same time, we should point out that it is uncertain whether we have managed to identify the true exchange rate effects in this study. One challenge is that it has become possible to buy more and more goods and services from abroad, which is difficult to control for in empirical models.

6. Summary

The main question in this memo has been how much of a tailwind the Norwegian economy has had from the krone's weakness in recent years. Simple empirical models indicate that exports from the mainland economy would have been 4% lower in 2017 without the weaker krone than they actually were, while imports would have been around 1% higher. Assuming that the other components of GDP are unaffected, this suggests that mainland GDP would have been slightly more than 1% lower in 2017 had the krone not fallen with oil prices from 2014. In our opinion, this gives grounds to conclude that the tailwind from the krone has been significant.

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

Appendix. Empirical models for exports and imports

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

The analysis above is based on empirical models for Norwegian exports and imports, estimated on quarterly data for the period 2000-2013/2017. These models take into account that changes in the krone exchange rate and other variables may have a delayed impact on foreign trade. Table 1 shows the estimated long-term coefficients for the export models when estimated on data up to and including Q4 2017. Table 2 shows the equivalent coefficients for the import model.

We have estimated models where subcategories of mainland exports are dependent on external demand and relative wage costs in a common currency. Relative wage costs are an indicator of the relative pricing of Norwegian export goods and competing foreign goods. As discussed above, such models are not well-suited to explaining exports of energy goods, seafood, industrial raw materials, financial services or social services. We have not therefore estimated models for these categories. Otherwise, exports are here categorised into *oil services etc.*, *tourism*, *other goods* and *other services*. The series for *oil services etc.* is the sum of the various series for exports of goods and services in the national accounts where the oil service industry accounts for a substantial share of exports. This aggregate thus includes some exports that are not oil-related. The model for *oil services etc.* therefore includes both global offshore investment and imports among Norway's trading partners as measures of external demand. Global offshore investment has a slightly stronger estimated effect than trading partner imports (see Table 1). The other three export models contain positive effects from trading partner imports.

Relative wage costs in a common currency are significant (and with the correct sign) in the models for *oil services etc.*, *tourism* and *other goods*. The estimated effects indicate that mainland exports will rise by almost 0.3% in volume terms in the longer term if the (real) krone exchange rate falls by 1%.

The import model includes the effects of Norwegian demand, relative wage costs in a common currency, and the export-to-GDP ratio for OECD countries. The last of these variables is intended to capture the effects of increased international specialisation over time and any special situations affecting trade flows, such as the financial crisis in 2008. The model indicates that movements in the krone exchange rate have little impact on imports.

NORGES BANK
STAFF MEMO
NO. 6 | 2019

HOW MUCH OF A TAILWIND
HAVE WE HAD FROM THE
WEAKER KRONE?

Table 1. Models for mainland exports

Long-term elasticities. Period: 2000 Q1 – 2017 Q4. Share of exports in 2017 in brackets

	Explanatory variables		
	Trading partner imports	Global offshore investment	Relative wage costs in common currency
Oil services etc.* (30%)	0.38	0.48	-0.63
Energy, seafood and industrial raw materials** (36%)	-	-	-
Other goods (12%)	0.57	-	-0.52
Tourism (7%)	0.90	-	-0.41
Financial and social services (5%)	-	-	-
Other services (10%)	1.06	-	-
Mainland exports (weighted average of estimates)	0.50	0.14	-0.28

* Categories of goods and services in the national accounts where the oil service industry accounts for a substantial share of exports.
** Energy goods comprise electricity and refined oil products. Basic materials consist of metals, mining products, forestry products and commodity chemicals.

Table 2. Model for imports

Long-term elasticities. Period: 2000 Q1 – 2017 Q4.

	Explanatory variables		
	Import-weighted demand*	Exports/GDP for OECD-countries	Relative wage costs in common currency
Imports	1.00	0.47	0.05

*) The components of demand are weighted using (fixed) weights that reflect the import content of each component. The weights are based on input-output calculations from Statistics Norway. After testing, the long-term elasticity has been set equal to 1.

18