INTERNATIONAL MONETARY FUND

IMF Country Report No. 16/215

NORWAY

SELECTED ISSUES

July 2016

This Selected Issues paper on Norway was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on June 9, 2016.

Copies of this report are available to the public from

International Monetary Fund • Publication Services
PO Box 92780 • Washington, D.C. 20090
Telephone: (202) 623-7430 • Fax: (202) 623-7201
E-mail: publications@imf.org Web: http://www.imf.org
Price: $18.00 per printed copy

International Monetary Fund
Washington, D.C.

INTERNATIONAL MONETARY FUND

NORWAY

SELECTED ISSUES

June 9, 2016

Approved By
The European Department

Prepared By Nathaniel Arnold, Nan Geng, Giang Ho, and Rima Turk

CONTENTS

BOXES

TABLES

APPENDICES

FIGURES

TABLES

APPENDICES

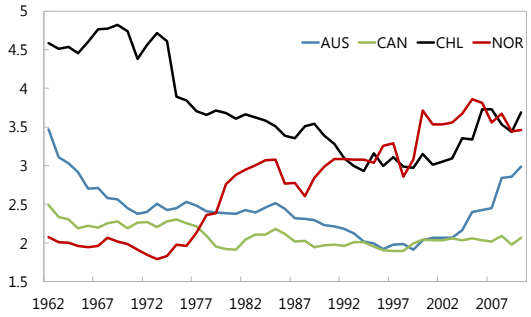
THE TRANSITION FROM OIL AND GAS[1]

As offshore investment drops from its peak and oil prices retreat from their high in 2014, the Norwegian economy is going through a transition away from oil dependence. This chapter first takes a historical perspective, studying the implications of the oil boom of the 2000s on industry structure and economy-wide productivity. It then examines the progress with the ongoing transition thus far both in the real sector and the labor market, bearing in mind the short time span that has passed. Finally, policies that may be helpful in facilitating a smooth adjustment are discussed.

A. Consequences of the Oil Boom

1. Norway's economy has grown increasingly focused on oil and gas. Exports of crude oil and gas accounted for about 57 percent of total goods exports in 2013. An index of export diversification—with higher value implying less diversified—shows that Norway's export structure has become increasingly concentrated since the oil discovery in the early 1970s, in contrast to the broad trends in other advanced commodity exporters such as Australia, Canada and Chile. Although the employment share of the oil and gas extraction sector is small at about 1 percent, this sector has provided rapidly increasing demand for mainland goods and services in terms of investment, intermediate consumption and wage costs, totaling 13 percent of mainland GDP in 2014 (IMF, 2015a). In addition, government income from oil-related revenue is high, at above 10 percent of GDP or 25 percent of total revenue.

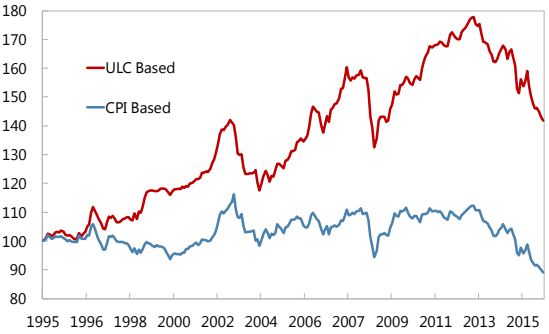
Export Diversification
(Index)



Sources: IMF Export Diversification Database and Fund staff calculations.
Note: Higher value of the index implies *lower* diversification.

2. The sound fiscal framework provides considerable but incomplete insulation from "Dutch disease" pressures. The Government Pension Fund Global (GPFG) and the fiscal rule together comprise a mechanism that delinks the earning and use of oil revenue, which helps insulate the fiscal budget from oil revenue fluctuations due to e.g. changes in oil prices (National Budget, 2016). However, insulation is not complete, as indicated by, for example, the rapidly increasing common-currency unit labor costs relative to trading partners, which have only been reversed somewhat recently due to depreciation of the krone exchange rate

Real Effective Exchange Rates
(Index: January 1995=100)



Sources: IMF Information Notice System and Fund staff calculations.

[1] Prepared by Giang Ho.

3. The paper starts by examining the consequences of the oil boom during the 2000s for the Norwegian economy. Specifically, this section explores how the industrial structure has evolved in response to the boom in the oil-related sector and the associated implications, including for aggregate productivity growth and the mainland economy's sensitivity to oil price developments. A backward-looking perspective is useful for drawing inferences about the future.

4. Theory predicts that a boom in the oil-related sector would lead to resource movement and spending effects. Corden and Neary (1982) presented a theoretical framework to study the "Dutch disease" mechanism in a small open economy with two traded goods sectors—e.g. oil-related and traditional/manufacturing—and a nontradables sector, e.g. services. The effects of a boom in the oil-related sector can be split in two. First, there will be a *resource movement effect*, by which resources will move from the rest of the economy to the oil-related sector as a result of high oil prices increasing the returns to factors of production in oil-related activity. Second, there will be a *spending effect*, by which higher income will boost the demand for services, resulting in higher employment in this sector. Thus, the theoretical implication of an oil boom for the traditional goods sector is unambiguously lower output/employment (relative to the outcome in the absence of a boom), whereas output/employment in the nontradables sector could be higher or lower depending on whether the resource movement effect or the spending effect dominates (see also Nordbo and Stensland, 2015). Both effects would lead to an increase in the relative price of services, i.e. a real appreciation of the exchange rate.

5. For analytical purposes, the Norwegian economy is roughly segmented into three sectors corresponding to those in the Corden-Neary framework. Given the extensive oil dependence of the mainland economy, it is difficult to precisely delineate the oil-related activity in the mainland economy using the standard industry classification. For example, Prestmo and others (2015) estimated that over 200,000 mainland jobs spanning a wide range of industries could be based on deliveries to the continental shelf.[2] In our analysis, the "oil-related" sector consists of the oil and gas extraction industry (including services incidental to oil and gas if separately defined) and the manufacturing industries with close links to oil and gas (i.e. machinery and equipment, shipbuilding).[3] The "traditional" sector consists of the remainder of manufacturing as well as agriculture and fishing, and the "nontradables" sector corresponds to business services.

[2] Including employment in oil-related exports industries, the figure would be higher.

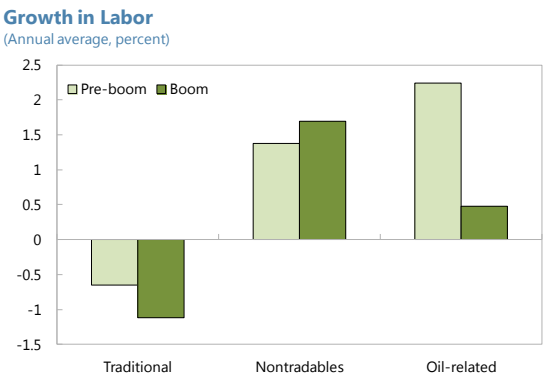
[3] Note that this is a narrow definition of the oil-related sector, which does not take into account the indirect deliveries to the oil sector from other industries.

6. There is some evidence that resources reallocated toward the oil-related and nontradables sectors during the oil boom (Figure 1). Comparing the pre-boom (1990–2002) to the boom period (2003–11), industry-level data from the OECD structural database point to a clear pick-up in the growth rates of both employment and capital stock in the nontradables sectors during the boom period, whereas they both declined in the traditional sector, in line with predictions from the Corden-Neary framework.[4] However, developments in the oil-related sector were rather mixed; while oil-related investment accelerated during the boom, the growth in oil-related employment seemed to have slowed in contrast to theoretical predictions. Nonetheless, the latter may reflect the narrow definition of the oil-related sector, i.e. not including industries with indirect deliveries to the offshore economy.

7. This reallocation also happened in other commodity exporters to varying degrees. IMF (2015b) performed a similar analysis for Australia, Canada, and Chile using industry-level data from the EU/World KLEMS database. In all three countries, there was a clear increase in the growth rates of both capital and labor in the extractive sector during the boom period. In Canada, the growth patterns of employment and investment in the manufacturing and nontradables sectors are also consistent with model-based predictions. However, the pace of capital accumulation in Australia's manufacturing sector picked up during the boom period reflecting in part strong demand from Asian export markets. Chile's manufacturing employment growth increased during the boom while capital accumulation slowed in nontradables. In sum, the Dutch disease mechanism seems to play out in varying ways in these three commodity exporters and Norway.

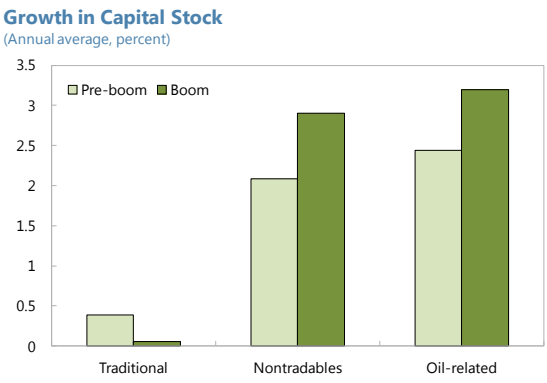
Figure 1. Reallocation of Labor and Capital

Labor moved to nontradables sector during the boom…



Sources: OECD STAN database and Fund staff calculations.

…and capital also reallocated to nontradables and oil-related sectors.



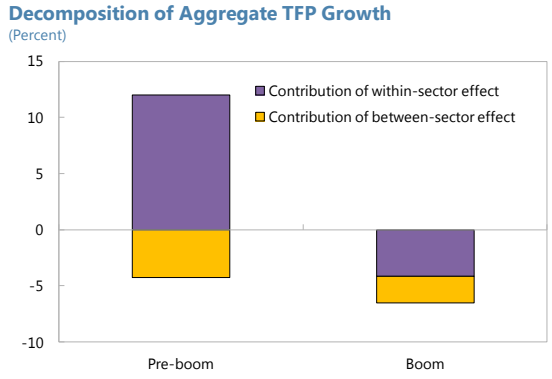
Sources: OECD STAN database and Fund staff calculations.

[4] Demand from the oil sector started to pick up in 2003 and continued strongly after the global financial crisis, thus we have defined the boom period to be 2003-2011 (the data series end in 2011).

8. Resource reallocation during the oil boom contributed to lowering productivity growth (Figure 2). Following Dabla-Norris and others (2015), growth in economy-wide total factor productivity (TFP) can be decomposed into within-sector and between-sector effects.[5] The within-sector effect reflects the contribution of within-sector productivity growth to aggregate productivity growth, whereas the between-sector effect captures the productivity impact of resource reallocation across sectors. Industry-level data from the OECD indicates that aggregate TFP growth turned negative in Norway during the oil boom while having been relatively strong during the previous decade. The decomposition suggests that the within-sector effect contributed about two-thirds of the decline in TFP during the boom period. A marked decline in nontradables productivity appears to be the key driver, although TFP also declined in the traditional and oil-related sectors, the latter partly reflecting declining production due to maturing fields and time-to-build between investment and production phases. Sectoral reallocation contributed the remaining one third to the TFP decline. However, this productivity-hampering impact of reallocation was also present even before the oil boom materialized. In addition, one aspect not captured in this simple analysis is the possible productivity spillovers from the oil-related to other sectors, as has been found for Norway in Bjornland and Thorsrud (2014).

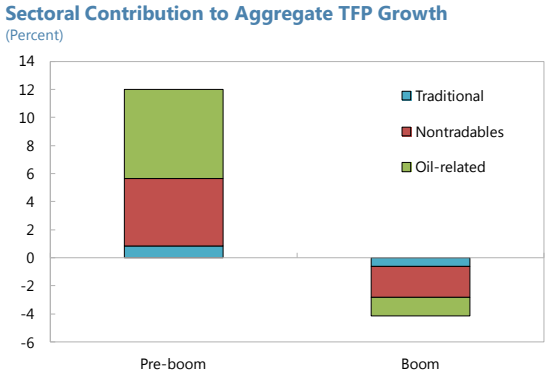
Figure 2. Decomposition of Productivity Growth

Reallocation contributed to reducing TFP growth,…



Sources: OECD STAN database and Fund staff calculations.

…as did weak within-sector TFP growth, mainly in nontradables.



Sources: OECD STAN database and Fund staff calculations.

[5] The decomposition is based on the following specification:

$$tfp_t - tfp_{t-1} = \sum_i \omega_{i,t-1}(tfp_{i,t} - tfp_{i,t-1}) + \sum_i tfp_{i,t}(\omega_{i,t} - \omega_{i,t-1})$$

in which i refers to the sectors (i.e. oil-related, traditional, and nontradables); tfp_t and $tfp_{i,t}$ refer to economy-wide and sectoral TFP, respectively; and $\omega_{i,t}$ is the share of real value added of sector i. The first term on the right side is the within-sector effect given by the weighted sum of TFP growth in each sector. The second term is the between-sector effect, capturing the effect of sectoral reallocation of real value added on aggregate TFP growth. Sectoral TFP is calculated as the Solow residual from a Cobb-Douglas production function with labor and capital as factors of production, where the labor share is computed at the sector level as the ratio between labor compensation and value added in the sector.

9. In addition to resource reallocation, there is evidence of deepening oil dependence in the mainland economy, including in traditional industries. The economy's input-output table can be used to trace how much intermediate input various industries supply to the oil sector, as well as how important the input to the oil sector is in an industry's total intermediate consumption. We take the latter as a rough measure of the degree of oil dependence for a given industry. We calculate this measure for all mainland industries using Norway's input-output tables for the pre-boom (mid-1990s) and boom (mid-2000s) periods. The calculation suggests that a number of mainland industries are increasingly dependent on the oil sector. Take the machinery and equipment rental industry, for example. Its supply to oil and gas activity accounted for over a quarter of its total intermediate consumption during the boom period, increasing from only 10 percent in the mid-1990s. Overall, oil dependence increased in two thirds of the industries considered.

Oil Dependence of Selected Industries

Industry	Oil dependence 1/ Mid-90s	Mid-00s
Other non-metallic mineral products	3.1	6.3
Machinery & equipment	3.5	7.3
Textiles, leather, footwear	4.6	13.8
Fabricated metal products	5.8	9.6
Other transport equipment 2/	16.0	17.0
Renting of machinery & equipment	10.8	27.1

Sources: OECD input-output databse and Fund staff calculations.
1/ Measured as input to oil sector as percentage of total intermediate consumption 2/ Includes shipbuilding

10. Growing oil dependence makes the mainland economy more susceptible to oil price fluctuations than in the past (Box 1). A panel regression analysis of 32 mainland manufacturing and services industries over the 1978–2015 period was conducted using the difference-in-difference approach (Box 1). The analysis suggests that for the post-2000 period, industries that are more dependent on the oil sector tended to experience higher real value added growth when oil prices were higher, while this effect was not present in the earlier years.[6] A corollary of this finding is that during the oil boom, rising oil prices allowed for a strong expansion of oil-dependent industries at the expense of other industries, causing the mainland economy to be increasingly focused on supplying oil and gas activity. If the effect also works in reverse, oil-dependent industries would be expected to suffer more relative to the rest of the economy at the current juncture as oil prices decline.

[6] This finding is consistent with e.g. Akram and Mumtaz (2016), who find evidence that the correlation between oil prices and macroeconomic variables in Norway (e.g., the nominal effective exchange rate) has increased during the 2000s.

Box 1. Growing Oil Dependence of Mainland Economy

This box investigates the extent to which oil prices affect the mainland economy using a difference-in-difference approach. In particular, we ask whether mainland industries that are more dependent on supplying the oil and gas sector experience higher real value added growth when oil prices are high. Oil dependence is measured in two ways, i.e. as the percentage of the industry's input to the oil sector in its total use or in total intermediate consumption. These measures are calculated from Norway's input-output table for 2013. The most oil-dependent mainland industries include repair services of computers and personal goods, machinery and equipment, repair and installation of machinery and equipment, and fabricated metal products, among others.

Oil Dependence, Top Ten Industries

Industry	Input to oil, % total use	Input to oil, % intermed. cons.
Repair services of computers and personal & household goods	17.6	22.8
Rental and leasing services	14.8	18.0
Machinery and equipment n.e.c.	12.0	23.0
Repair and installation services of machinery and equipment	10.5	15.1
Fabricated metal products, except machinery and equipment	10.1	10.7
Other non-metallic mineral products	7.5	7.7
Basic pharmaceutical products & pharmaceutical preparations	6.4	13.4
Financial services, except insurance and pension funding	6.0	9.6
Rubber and plastics products	5.9	6.8
Basic metals	5.5	10.3

Sources: Statistics Norway's 2013 input-output table and Fund staff calculations.

The empirical strategy is similar to that in Dell'Ariccia and others (2008)' work on banking crises and involves estimating the following specification:

$$y_{it} = \alpha_i + \beta Poil_t * Oildep_i + \varphi Share_{i,t-1} + \mu_t + \varepsilon_{it}$$

where y_{it}, the growth rate of real value added in industry i in time t, is regressed on an interaction term equal to the product of the price of oil in time t and a measure of oil dependence for industry i. The regression also includes the lagged value added share of industry i to account for "convergence" effects, (i.e. the tendency of larger industries to experience slower growth), as well as a full set of industry and year fixed effects. A positive and significant β would indicate that oil price developments have larger impact on industries that are more dependent on supplying the offshore sector. The model is estimated using Statistics Norway's data for 32 mainland industries (including both manufacturing and services) over 1978Q1–2015Q4.

Results suggest that mainland industries are increasingly sensitive to oil price fluctuations through their growing oil dependence. The coefficient on the interaction term is positive and significant for the post-2000 period using either measure of oil dependence, indicating that higher oil prices are associated with more rapid expansion of industries that are more reliant on the oil sector. For example, using Model 1's coefficient, a 10 percent increase in oil prices is associated with a 7 percent increase in real value added for an industry with oil dependence at the 25th percentile, compared to over 18 percent for an industry with oil dependence at the 75th percentile. However, this differentiated effect is not statistically significant in pre-2000 data, which could be interpreted as reflecting two possibilities. First, the oil boom may have changed the relationship between oil prices and the non-oil economy, i.e. there may be nonlinear effects. Second, the structure of the economy may have evolved (in terms of tightening their links to oil production during the oil boom of the 2000s) such that the 2013 input-output table is not an accurate description of past structure.

Impact of Oil Prices on Oil Dependent Industries

	Pre-2000		Post-2000	
	Model 1	Model 2	Model 1	Model 2
Oil prices*Oil dependence	0.065	0.116	0.249	0.149
	[0.161]	[0.093]	[0.118]**	[0.068]**
Observations	2,688	2,688	2,048	2,048
R-squared	0.070	0.074	0.084	0.085

Source: Fund staff estimates. Notes: Dependent variable is industry real value added growth. Models 1 and 2 use two measures of oil dependence (input to oil as % of total use and as % of total intermediate consumption, respectively). Industry and year fixed effects are included. Sample consists of 32 industries over 1978-2015 (quarterly frequency). Robust standard errors in brackets. Statistical significance ** 5%.

B. An Economy in Transition

11. While oil sector activity has been declining, a sustained pick up in the share of the traditional goods sector has yet to occur (Figure 3). The transition from oil and gas is a gradual process, and more time would be required before a credible assessment can be made of its progress. The preliminary data show an ongoing marked decline in oil-related production and investment, whereas activity in the traditional goods sector is holding up but not sufficiently to pick up the slack. The divergent performance is perhaps most pronounced within manufacturing between oil-related industries (i.e. machinery and equipment, ships, boats and oil platforms) and nonoil industries.[7] Overall, although the real value added share of the oil-related sector has shrunk from over 36 percent on average during 2000–13 to about 29 percent during 2014–15, much of this appears to have been picked up by the business services sector. The traditional goods-producing sector remains a relatively small part of the economy, with value added share at a little over 7 percent and hours worked share declining to 11 percent.

Share in Total Economy (percent)

	Value added		Hour	
	2000-13	2014-15	2000-13	2014-15
Oil-related	36.4	29.3	9.2	9.2
Traditional	7.2	7.4	13.3	10.9
Business services	32.3	36.5	45.2	46.0

Sources: Statistics Norway and Fund staff calculations.

12. However, the weak krone is providing significant cushion for mainland businesses. The depreciated exchange rate is not only temporarily boosting traditional goods exports; it is also improving the adaptability of firms in the oil-related sector. For example, a survey of oil service enterprises in Norges Bank's regional network covering some 40,000 employees indicates that an increasing number of enterprises are reporting higher ability to replace the decline in oil-related turnover with sales in other markets. Oil service enterprises (e.g., in shipbuilding, maritime equipment) have been able to win contracts in alternative markets such as aquaculture and offshore wind power thanks to the improved cost competitiveness (Brander and others, 2016).

13. Meanwhile, labor is inevitably being released from oil-related sectors (Figure 4). Statistics Norway (2015) estimated that, in 2014, there were about 84,000 workers employed in the oil-related sector (not including mainland industries with indirect deliveries to the oil sector)—a 2.3 percent increase from 2013, compared to 6.5 and 10.9 percent in 2013 and 2012, respectively.[8] Rising unemployment (4.8 percent in January—the highest level in a decade) continues to be concentrated mainly in the oil-related parts of the economy. The oil-producing region of Rogaland—home to the oil capital of Stavanger—is seeing a steep rise in unemployment from a lower-than-average level, and net migration to the region has also experienced a marked decline.

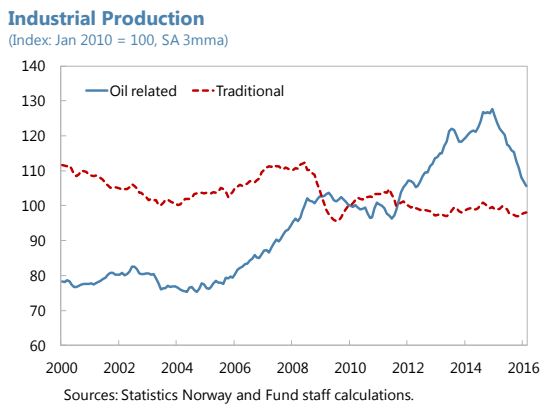
[7] For example, in February 2016, production in machinery and equipment and ships, boats and oil platforms fell by 18.6 and 19.6 percent (y/y), respectively, while production of chemicals and pharmaceutical products increased by 6 percent.

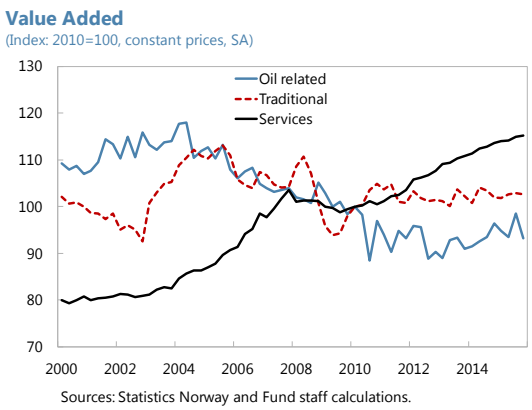
[8] Statistics Norway defines this sector to consist of oil and gas extraction, services incidental to oil and gas, pipeline and related services, and construction and installation of oil platforms.

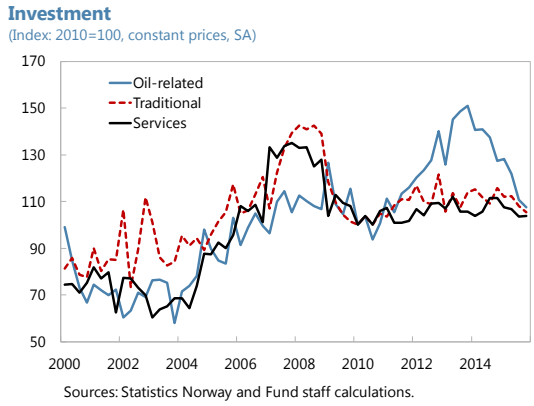
Broken down by age and profession, oil-related employment fell mainly for the categories of "technicians and associate professionals" (e.g., engineers) and those in the 25–54 age group. Meanwhile, job vacancies have fallen significantly in the oil-related sector and wage growth slowed, although per hour pay still stands substantially higher than in other sectors.

14. Labor mobility across sectors and regions is crucial to reduce oil-related unemployment. Labor mobility is generally high in Norway even when compared to the Nordic neighbors with very flexible labor markets. For example, the probabilities of transitioning from unemployment to employment as well as from temporary to permanent employment are higher in Norway than in the other Nordic countries. Norway also ranks second only to Denmark in terms of occupational and workplace mobility (Nordic Council of Ministers, 2010). However, the extent to which this high mobility reflects Norwegian labor market institutions and policy or the relatively favorable economic conditions at the time of study is debatable. The incidence of long-term unemployment—albeit still well below OECD average—has increased steadily since 2012 (OECD, 2015). There is also evidence that the level of labor mobility is lower among Norwegians compared to other nationalities (Stambol, 2005; Roed and Schone, 2012).

Figure 3. Real Sector Developments







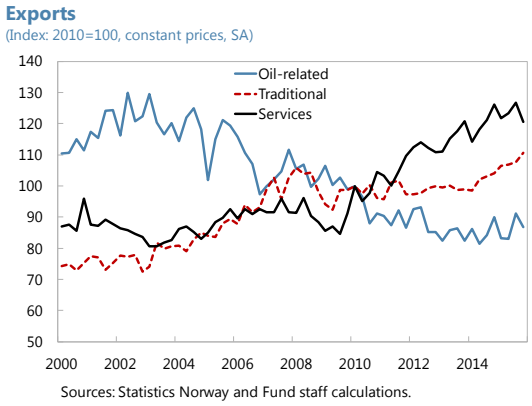
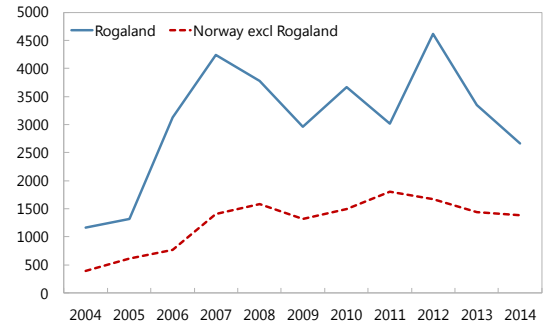


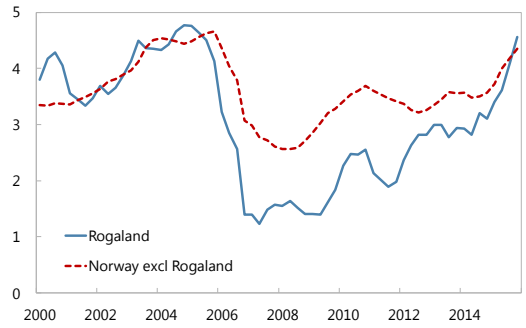
Figure 4. Labor Market Developments

Net Migration
(Number of people)



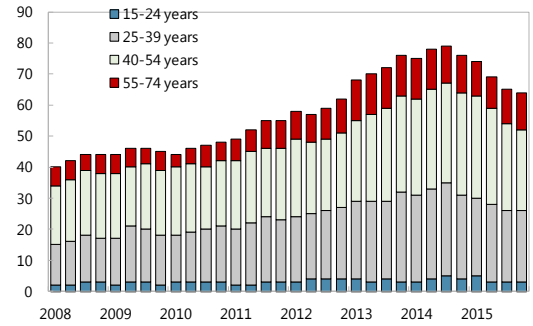
Sources: Statistics Norway and Fund staff calculations.

Unemployment rate
(Percent, 4-quarter moving average)



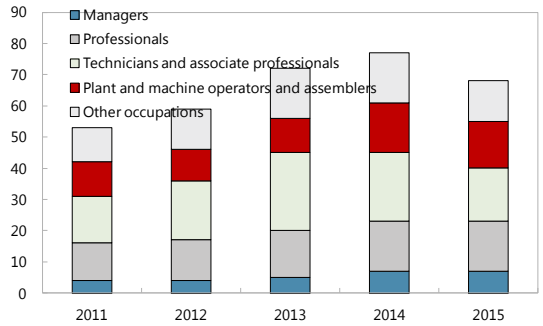
Sources: Statistics Norway and Fund staff calculations.

Employed Persons in Oil Sector, by Age Group
(Thousand)



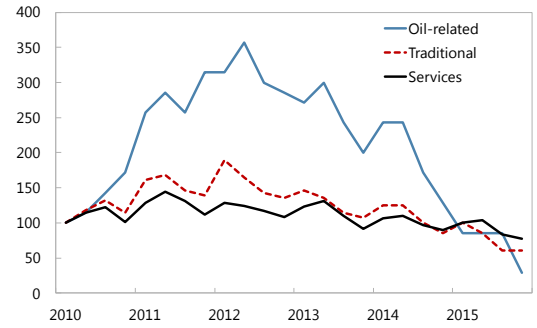
Sources: Statistics Norway and Fund staff calculations.

Employed Persons in Oil Sector, by Profession
(Thousand)



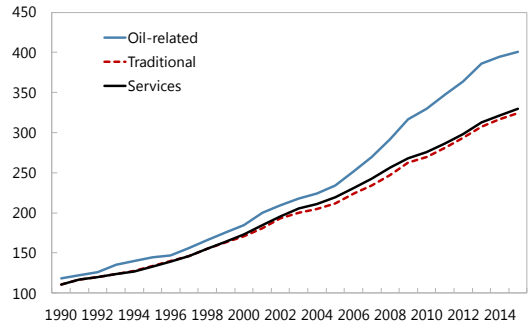
Sources: Statistics Norway and Fund staff calculations.

Job Vacancies
(Index: 2010 = 100)



Sources: Statistics Norway and Fund staff calculations.

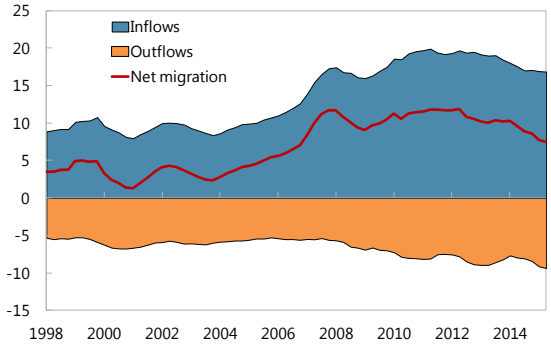
Wages and Salaries per Hour Worked
(NOK)



Sources: Statistics Norway and Fund staff calculations.

15. One mechanism that could dampen the rise in unemployment is flexible labor supply by immigrants. Immigrants—mainly from Western Europe and other advanced economies—account for about 13 percent of oil-related sector employment, having increased from 5.5 percent in 2003 (Statistics Norway, 2015). Some foreign workers could—if faced with unemployment—choose to return to their home countries or to migrate to a third country where employment prospects are brighter. Recent data indicate that net immigration to Norway—although still positive—declined by 22 percent in 2015, driven by lower inflows but also increasing outflows.[9] If this trend continues, however, Norway's potential growth would be reduced, particularly given that the level of human capital among oil sector workers is distinctly higher than that in the rest of the economy.

Net Migration
(Thousand)



Sources: Statistics Norway and Fund staff calculations.

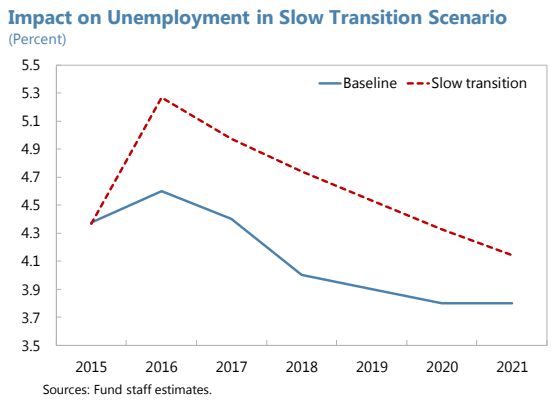
16. In a scenario of slow transition, unemployment would rise further and growth would stay weak for longer (Figure 5). The number of oil-related jobs that will eventually be lost in the ongoing downturn is highly uncertain. It has been reported that, to date, about 25,000 workers in oil-related industries have been dismissed (Prestmo and others, 2015). Others project a decline of 50,000 oil-related jobs until 2017 (Blomgren and others, 2016). For the purpose of a downside scenario in which the transition from oil dependence would be more prolonged than expected, a conservative estimate of 40,000 is assumed. It is then assumed that out of these 40,000 lost jobs, only a third would be replaced in 2016, and that it would take the next five years to replace all lost jobs. In such a scenario, unemployment would peak at 5.3 percent in 2016 (compared to 4.6 percent in the baseline forecast) and slowly decline thereafter, while growth would reach the trough at ½ percent in 2016 (compared to a recovery to 1¼ percent in the baseline).[10] While the impact appears relatively benign, the experiment is highly stylized and does not take into account the possible negative spillovers to other sectors' labor markets (e.g., labor released from the oil sector may displace jobs in other sectors). On the other hand, the flexible nature of Norway's labor market may provide a cushion and mitigate the increase in unemployment.

[9] However, it would also depend on the composition of the outflows, e.g. immigrants of Nordic background would be more likely to return home than those from Eastern Europe.

[10] In estimating the growth impact, it is assumed that higher unemployment would subtract 1ppt from household consumption and private investment growth in 2016 and 0.5ppt for each year during 2017–21, using the estimated empirical relationship between employment and consumption/investment. Mainland exports would also be affected given lower investment.

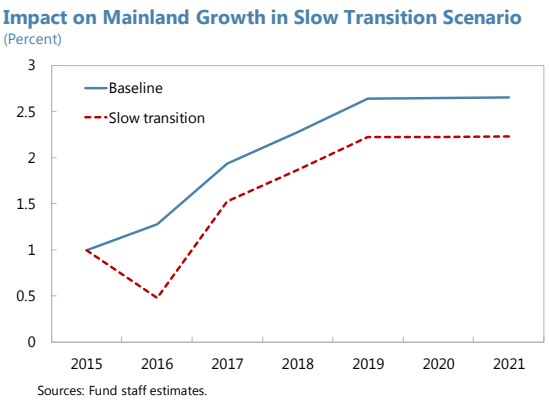
Figure 5. Slow Transition Scenario

Unemployment would peak at 5.3 percent…



Sources: Fund staff estimates.

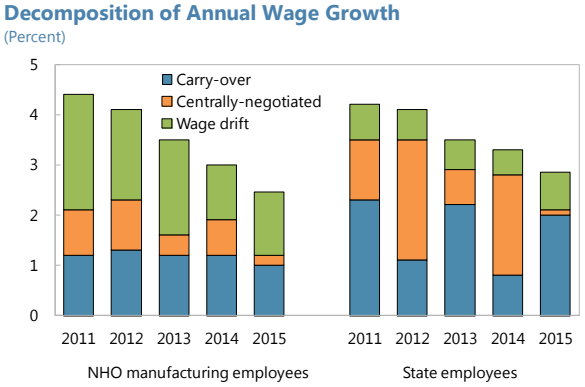
…and growth would stay weak for longer.



Sources: Fund staff estimates.

C. Policies to Facilitate the Transition

17. Wage formation will play an important role in facilitating labor movements and ensuring international competitiveness. Norway has a strong and effective collective bargaining system (Box 2), which has promoted wage growth in line with productivity gains and peaceful industrial relations. Since the beginning of the downturn, the social partners have demonstrated flexibility in the system by delivering historically low wage growth (i.e. 2.8 percent in 2015), expected to be even lower in 2016. The centrally-negotiated increment in 2015 was only 0.3 percent on average across industries (0.2 percent in manufacturing and 0.1 percent in the public sector). Low wage growth has complemented the competitive exchange rate in lowering Norway's unit labor cost relative to trading partners, in addition to dampening domestic inflationary pressures and allowing monetary policy to stay accommodative. The wage setting model will continue to be tested in the coming years, particularly given high immigration and increasing service sector share which contribute to reducing union density and weakening coordination in wage determination (Productivity Commission, 2016). In addition, the compressed wage structure may limit the extent of labor reallocation across sectors.



Sources: Norwegian Technical Calculation Committee for Wage Settlements 2016 Report and Fund staff calculations.

18. Labor market policies can support the transition by improving the efficiency of the search and matching process. Workers in the oil-related sector (e.g., engineers) tend to be highly educated and mobile, and predominantly male in the 30–54 age group (Statistics Norway, 2015). Their energy-related expertise could be relatively easily transferred to other similar types of jobs.

Thus, improving information available to the job seekers about economic prospects and job openings in different industries, as well as active labor market policies such as retraining can play an important role in helping the displaced oil workers find new employment. In addition, making unemployment benefits more activity-oriented, such as by introducing activity requirements and breakpoints, can help reduce reservation wages and encourage labor force participation (see also Productivity Commission, 2016).

19. Macroeconomic policies should also promote structural adjustment. Monetary policy should support demand and preserve price stability, thereby creating a favorable economic environment for private sector firms to thrive. Fiscal stimulus measures should focus on expanding the economy's productive capacity while avoiding crowding out tradable goods and services production. The 2016 budget takes an important step in the right direction by proposing a tax reform agenda that promotes saving and investment and makes Norway's tax system more internationally competitive. More generally, it is important that counter-cyclical policies not become counter-structural (Nicolaisen, 2016). In the medium term, a reconsideration of the fiscal framework along the lines of the fiscal rule commission's recommendations would help better smooth spending of oil revenue and relieve "Dutch disease" pressures that may impede the necessary transition.[11]

20. Other policies would also help. Reducing the constraints to new housing construction particularly in big cities such as Oslo would help relieve pressures on housing prices and make it easier for people to move to areas where employment prospects are favorable. Over the longer term, investing in research and innovation—an area where Norway is lagging peers—and doing so efficiently would help attract resources to the "new economy" or "knowledge-based economy" that would ultimately replace natural resources (see also Productivity Commission, 2016).[12]

[11] See also Commission on Fiscal Rule (2015).

[12] See also Chapter 2 of the Selected Issues Papers.

Box 2. Collective Bargaining in Norway

The organizational structure of the collective bargaining system is centralized and hierarchic.[1] Norway has approximately 90 national unions and four main confederations. More than 90 percent of the unionized workers are affiliated with one of those main confederations. The Norwegian Confederation of Trade Unions (LO) is the oldest and largest of the main confederations, and has a strong position in both the private and the public sector. National unions and confederations have their counterparts in a corresponding organizational structure on the employers' side. The unionization rate has been stable and, at 52 percent, is lower than in the neighboring Nordic countries. However, unionization rates vary strongly between industries. Approximately 80 percent of all employees in the public sector are unionized, whereas the corresponding figure is 50 percent in private manufacturing industries and about one third in private services. Generally, there exists a tradition for cooperation and social dialogue between the government, trade unions, and employers' associations.

Collective bargaining in Norway is highly coordinated, resulting in a compressed wage structure. The Norwegian model for wage formation—introduced in the 1960s—is characterized by the so-called "trend-setting industries model," in which wage growth in industries that compete in the international market, e.g. manufacturing, establish a norm for the remainder of the labor market. The model establishes an anchor for wage increases in the public sector and domestic-oriented industries, ensuring strong links between wage and productivity growth as well as distributing gains resulting from productivity growth in the exposed private sector to the rest of the economy. The trend-setting industries model has recently faced challenges due to increased labor migration as well as high wage pressures in the oil-related part of the manufacturing sector. In December 2013, a government-appointment commission, including representatives of the social partners, nevertheless concluded that the trend-setting industries model is the best way to achieve beneficial socioeconomic results and therefore did not recommend any changes to wage formation.

Bargaining follows a two-tier system and takes place at central as well as local/enterprise levels. The so-called "tariff wages" are set first at the central level. Next, the tariff wages are supplemented by local wage adjustments—or "wage drift"—bargained at the local level. Wage drifts have on average contributed about 40 percent and 60 percent to total wage increases for blue collar and white collar workers, respectively, over 1995–2010. Since the 1990s, local bargaining has also been common in the public sector.

Collective agreements: National collective agreements predominate. The central-level organizations are invariably part of the agreements and industrial relations are regulated by basic agreements. Collective agreements are valid for a period of two years, and wage rates are renegotiated in the interim year. Approximately half of all private sector employees and two thirds of all employees are covered by a collective agreement. General application of minimum provisions of the collective agreements has been adopted in certain industries (e.g., construction, cleaning, and agriculture) where immigrant workers have less favorable wage and labor conditions than the standards.

[1] The information in this Box is drawn from Nergaard (2014) and Barth and others (2015).

References

Akram, Q. F. and H. Mumtaz, 2016, "The Role of Oil Prices and Monetary Policy in the Norwegian Economy Since the 1980s," Norges Bank Working Paper 1/2016.

Barth E., K. O. Moene, and F. Willumsen, 2015, "The Scandinavian Model—An Interpretation," University of Oslo working paper.

Bjornland, H. C. and L. A. Thorsrud, 2014, "Boom or Gloom? Examining the Dutch Disease in Two-Speed Economies," Center for Applied Macro and Petroleum Economics Working Paper 6/2014.

Blomgren, A., C. Quale, and A. M. Harstad, 2016, "Trends in Direct Petroleum-Related Employment, 2014-2020," IRIS Working Paper 2016/029 (in Norwegian).

Brander A. S., H. Brekke, and B. E. Naug, "Greater Adaptability in the Norwegian Oil Service Industry," Norges Bank Economic Commentary No. 4, 2016.

Commision on Fiscal Rule, 2015, Press release.

Corden, W. M. and J. P. Neary, 1982, "Booming Sector and De-Industrialization in a Small Open Economy," *The Economic Journal,* Vol. 92, No. 368, pp. 825-848.

Dabla-Norris, E., S. Guo, V. Haksar, M. Kim, K. Kochhar, K. Wiseman, and A. Zdzienicka, 2015, "The New Normal: A Sector-Level Perspective on Productivity Trends in Advanced Economies," IMF Staff Discussion Note 15/03.

Dell'Ariccia, G., E. Detragiache, and R. Rajan, 2008, "The Real Effects of Banking Crises," *Journal of Financial Intermediation,* Vol. 17, No. 1, pp. 89-112.

International Monetary Fund (IMF), 2015a, "Norway's Economy with a Maturing Oil and Gas Industry," Selected Issues Paper, Chapter 1.

———, 2015b, "Where Are Commodity Exporters Headed? Output Growth in the Aftermath of the Commodity Boom," *World Economic Outlook* Chapter 2, October 2015.

Ministry of Finance, 2016, "The National Budget 2016."

Nergaard K., 2014, "Trade Unions in Norway: Coordinated Wage Bargaining and Workplace Level Co-determination," Fafo Institute for Labor and Social Research Report.

Nicolaisen, J., 2016, "Can Crises Be Curbed," Speech by Deputy Governor of the Norges Bank at the Norwegian Academy of Science and Letters, April 2016.

Nordbo, E. W. and N. Stensland, 2015, "The Petroleum Sector and the Norwegian Economy," Norges Bank Economic Commentary No. 4, 2015.

Nordic Council of Ministers, 2010, "Labor Market Mobility in Nordic Welfare States," Report.

Norges Bank, 2015, "Monetary Policy Report," June 2015.

OECD, 2015, "Employment Outlook," July 2015.

Prestmo, B. J., B. Strom, and H. K. Midsem, 2015, "Ripple Effects of the Petroleum Industry in the Norwegian Economy," Statistics Norway Report (in Norwegian).

Productivity Commission, 2016, Second-phase Report (in Norwegian).

Roed, M. and P. Schone, 2012, "Does Immigration Increase Labor Market Flexibility?" *Labor Economics,* Vol. 19, No. 4, pp. 527-540.

Stambol, L. S., 2005, "Urban and Regional Labor Market Mobility in Norway," Statistics Norway Report.

Statistics Norway, 2015, "Employees in the Petroleum Industry and Related Industries in 2014," Report 2015/48 (in Norwegian).

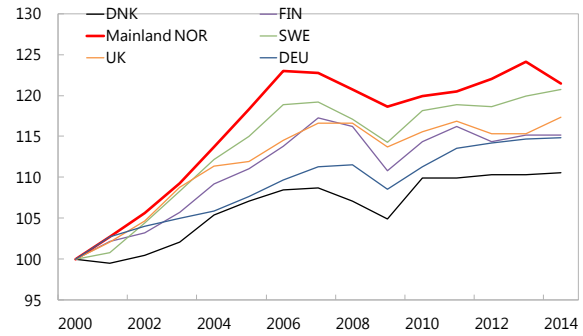
A FIRM-LEVEL ANALYSIS OF PRODUCTIVITY IN NORWAY[1]

As Norway undergoes a transition away from oil and gas, boosting external competitiveness and in particular productivity is crucial to create a dynamic non-oil tradable sector that could potentially replace oil and gas. Meanwhile, productivity growth in Norway has faltered for the past decade compared to peers, reflecting both cyclical and structural factors. This paper explores two possible explanations for the lagging productivity performance, namely product market regulation (PMR) and the low level of research and innovation. An extensive dataset of mainland Norwegian firms is used to empirically assess the potential productivity gains from product market reforms as well as increasing research and development (R&D) spending.

A. Introduction

1. Norway has experienced a sharp fall in productivity growth since the mid-2000s. Norway's average labor productivity—as measured by real output per hour worked in the mainland economy—grew rapidly during the first half of the 2000s, but started losing ground around 2005. Productivity growth in the private sector of mainland Norway has dropped from about 3 percent per annum in the 1996–2005 period to 0.8 percent during 2006–14. The slowdown in productivity trends also occurred in other advanced economies. In Norway, the relatively sharp slowdown was in part due to structural factors such as growth in labor migration that resulted in employment expansion in low skilled-intensive sectors (Productivity Commission, 2016). In addition, resource reallocation from the traditional to the oil-related and nontradable sectors during the oil boom in the 2000s—a symptom of the "Dutch disease" effects—appears to have also contributed to declining aggregate productivity growth (see first chapter of the Selected Issues).[2]

Labor Productivity in Selected Countries
(Index, 2000=100)



Sources: OECD and Fund staff calculations.
Note: Labor productivity is GDP per hour worked in 2005 international US$.

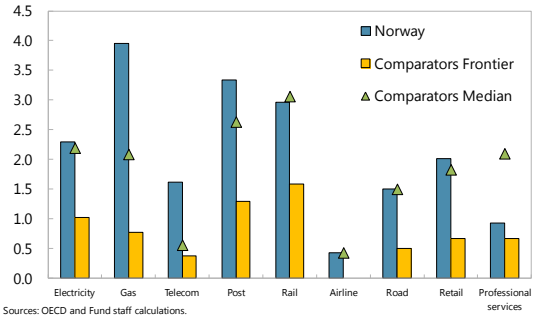
2. Meanwhile, there is scope to further ease product market regulation and enhance innovation. Norway ranks favorably compared with peers in many indicators of business environment and entrepreneurship such as access to finance, bankruptcy legislation, and firm birth rates (Nordic Innovation, 2012). However, the OECD's indicator of product market regulation (PMR)

[1] Prepared by Nan Geng, Giang Ho, and Rima Turk.

[2] The traditional sector typically consists of all non-oil tradable activities (e.g., non-oil manufacturing and agriculture/fishing).

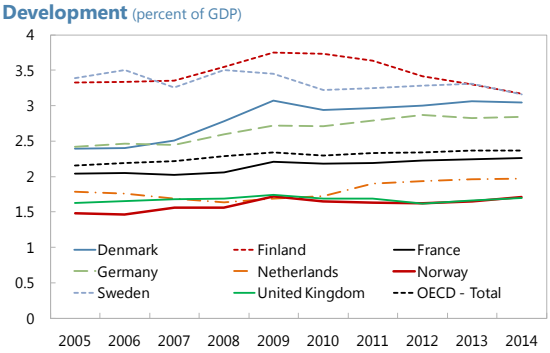
at the sector level indicate that several sectors (such as electricity, gas, rail, postal services, and retail) remain more regulated compared with best practice in peer countries.[3] Barriers to entrepreneurship in general have declined more slowly than elsewhere (OECD, 2016). Also, research and innovation activity as measured by gross domestic expenditure on R&D lags behind other advanced economies at similar income levels. These factors could be constraining productivity growth and dampening private sector dynamics in the Norwegian mainland economy.

Norway: Product Market Regulation, 2013



Sources: OECD and Fund staff calculations.
Note: PMR indicators range from 0 to 6, increasing with restrictiveness. Comparator group include Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Island, Ireland, Italy, Japan, Korea, Luxemburg, Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, and United Kingkom. Frontier refers to average best three countries in the comparator group.

Gross Domestic Expenditure on Research and Experimental Development (percent of GDP)



Sources: OECD and Fund staff calculations.

3. The paper is organized as follows. Section B briefly discusses the factors constraining business dynamics in Norway, including product market regulation and the low level of research and innovation. Section C offers a quantitative perspective, using an extensive firm-level dataset to estimate the potential productivity payoffs from relaxing regulatory burden or increasing R&D investment. Section D concludes.

B. Obstacles to Private Sector Growth in Norway

Product market regulation

4. Some sectors in Norway including network industries and retail trade present scope for further deregulation.[4] State ownership has diminished but remains extensive—companies with partial or complete state ownership (e.g., Statoil, Telenor, Norsk Hydro) account for about 11 percent of total employment (IMF, 2014). The government is intending further partial or complete sell-offs in a number of companies, including reduction in the state's holding of Telenor to 34 percent (OECD, 2016). While competitive market models are operating reasonably well in telecoms and electricity, in part due to participation in an integrated open market with other Nordic countries, rail and postal services have only been partially liberalized. Recent policy initiatives aimed at improving competition in network industries include reorganizing the railway sector, establishing

[3] The "best practice" or "frontier" is calculated as the average of the three best performing countries in the comparator group. For example, the frontier for network industries as a whole consists of the UK, Germany, and Australia, while for retail industry Sweden, Australia, and New Zealand.

[4] Network sectors include air transport, electricity, gas, post, rail, road transport, and telecom.

a new road development enterprise, and reducing Norges Posten's monopoly on postal services (National Budget, 2016; OECD, 2016). In the retail sector, exemptions from the Competition Act still apply in book retailing, and barriers to entry remain high particularly in the grocery market (Revised National Budget, 2016). The government has proposed significant liberalization of shop opening hours, including allowing all shops to open on Sundays (OECD, 2016), but this proposal has yet to be passed by the Parliament. On the other hand, professional services (e.g., legal, accounting, engineering) appear comparatively liberalized according to the OECD indicators.

5. The relationship between product market reforms and firm productivity enjoys theoretical and empirical support. Regulations that prevent firm entry and exit can restrict competition and reduce information available to consumers. Relaxing barriers to entry (such as regulated prices or licensing requirements) would allow new productive firms to enter the market and increase competitive pressures, thereby encouraging incumbent firms to cut costs and/or improve product quality, and ultimately improve productivity. Such reforms could generate productivity gains that go beyond firms in the regulated markets by affecting downstream producers who rely on inputs from the regulated upstream sectors. For example, the deregulation of network industries could result in cheaper and better quality of network services, producing ripple effects throughout the economy. Indeed, a growing body of literature shows that benefits from reducing anti-competitive regulation extend beyond the immediate sectors being liberalized.[5]

6. The adverse impact of product market regulation on productivity may well be more pronounced for high-tech and knowledge-intensive sectors. A number of studies have used the framework of Aghion and Howitt (2005) to document that anti-competitive regulation hinders productivity growth in high-tech and knowledge-intensive sectors, which make intensive use of high skilled labor and ICT capital inputs. Since regulation of services hampers the efficient and dynamic allocation of resources among firms, it also slows down growth in ICT-using sectors, which use intermediate service inputs more intensively than other sectors. Moreover, an important channel through which restrictive regulations limit productivity growth is by hindering the process of convergence to best practice productivity. Such adverse effects are stronger for firms that are closer to the technology frontier and international best practices because they rely on innovation rather than imitation (Nicoletti and Scarpetta, 2003; Conway and Nicoletti, 2006; Arnold, Nicoletti, and Scarpetta, 2008).

Research and innovation

7. Despite having expanded in scope and quality over the last 20 years, Norway's level of research and innovation remains low compared to peers. Not only does Norway spend less than advanced neighboring economies on R&D, it is also less efficient in translating R&D spending into

[5] A number of papers have documented the presence of adverse effects from upstream inefficiencies using input-output linkages in a single country context (Arnold and others, 2011; Forlani, 2012; Correa-López and Doménech, 2014; Lanau and Topalova, 2016) and across OECD countries (Barone and Cingano, 2011; Bourlès and others, 2013).

innovation results.[6] In its second-phase report, the Productivity Commission pointed out several reasons for this poor performance, including priorities and criteria influencing research funding allocation and research institutions' management and adaptability. The Commission recommended strengthening professional strategic management at the research institutions, better cooperation between research and industry, and implementation of measures for scientific quality in funding decisions, among others (Productivity Commission, 2016). In addition, competition-enhancing product market reforms may also boost innovation activity, given that competition up to a certain level tends to induce firms to innovate (Aghion and others, 2005).[7]

8. Work to enhance the efficiency of Norway's research sector is underway. In particular, the 2016 budget proposed several measures to support innovation activity, such as increasing the maximum deductibility basis under the SkatteFUNN (i.e. the Research Council of Norway) R&D tax incentive scheme and expanding appropriations for Innovation Norway's entrepreneurship grant scheme and pre-seed capital fund (National Budget, 2016). The government is also reviewing the system of funding allocation by the Research Council of Norway to ensure quality of awarded projects and reduce administrative costs (Revised National Budget, 2016).

9. A large literature has found evidence for a positive association between R&D and productivity. While empirical estimates of the impact of R&D spending on productivity growth range from zero to substantial, a general consensus that R&D has productivity-enhancing effects appears to have emerged (see e.g., Congressional Budget Office, 2005 for a review). The rate of return on R&D has been found to be of about the same size or slightly larger than that for conventional investments.

C. A Quantitative Perspective

10. In this section, we attempt to quantify the productivity gains from relaxing product market regulation and improving innovation. While the relationships between product market reforms or innovation and productivity have been widely explored in a cross-country context, to our knowledge it has not been done specifically for Norway, at least in the recent literature. In addition, our contribution is to utilize the rich information available in firm-level data to investigate this question.

[6] For example, Norway's innovation efficiency score—which captures the ratio of innovation output to input—is low at around 0.7, ranking at the 56th percentile among 141 economies (Cornell University, INSEAD, and World International Property Organization, 2015). The number of patents per capita also considerably lags other advanced economies. In addition, Norway appears to have significantly fewer "unicorns", i.e. start-up companies with a value of over $1bn, and employment in high-growth companies is also lower than in comparable countries (Productivity Commission, 2016).

[7] Aghion and others (2005) hypothesize that the relationship between competition and innovation follows an inverted U-shape, with higher competition initially increasing then decreasing the rate of innovation.

Firm-level data

11. An extensive firm-level dataset is employed to estimate the productivity payoffs of reforms. The Orbis database compiled by Bureau Van Dijk provides financial data at the firm level on value added, number of employees, and fixed assets, among other variables, allowing for the computation of firm-level productivity and other measures of firm performance. We focus on firms in the non-financial, non-oil private sector, and apply an extensive procedure to prepare the data for the analysis, including removing firms with missing key information or extreme values of financial ratios.[8] The final (post-cleaning) Norway sample consists of 80,474 public and private firms for the period between 2005 and 2014, resulting in over 125,000 firm-year observations.[9]

12. We calculate different measures of firm productivity for the analysis. Specifically, we compute both labor productivity (i.e., real value added per worker) and three measures of total factor productivity (TFP) for each firm using three different methodologies (Box 1).

Box 1. Measures of Firm-Level TFP

Three measures of firm TFP are computed for the analysis. First, an index number-based TFP measure is calculated as the Solow residual from a Cobb-Douglas production function with labor and capital as factors of production. For each 1-digit NACE sector, the labor and capital shares are obtained from the OECD STAN database. The Cobb-Douglas production function has the general form:

$$A_{ist} = Y_{ist} / \left[L_{ist}^{\alpha_s} K_{ist}^{1-\alpha_s} \right]$$

Where A_{ist} denotes TFP of firm i in sector s in year t, Y_{ist} is real value added, L_{ist} is the number of employees, K_{ist} is the firm's value of real fixed assets, and α_s denotes labor share in sector s. Thus, the assumption of constant returns to scale in every sector is made.

Second, a production function of the following form is estimated using OLS for each NACE sector:

$$lnY_{ist} = \beta_s + \alpha_s^L lnL_{ist} + \alpha_s^K lnK_{ist} + \gamma_t + \varepsilon_{ist}$$

Year fixed effects are included to capture time-varying common shocks to all sectors. We obtain the labor and capital shares from the regressions (no longer assuming constant returns to scale), and use them to compute firm TFP as before.

Third, we estimate the same production function but using the Levinsohn-Petrin (LP) methodology of instrumenting for the unobserved productivity shock (Levinsohn and Petrin, 2003). The idea is that more productive firms tend to hire more inputs, thus rendering input use correlated with productivity and causing the OLS coefficients to be inconsistent and biased. In line with the literature, we use as instrument the firm's working capital (defined as the difference between current assets and current liabilities), in the absence of good data on intermediate inputs. The three measures of firm TFP are highly and significantly correlated with each other. The simple correlations range from 0.45 to 0.76.

[8] See Appendix I for a description of the sample and the procedure we implement to prepare the Orbis data for analysis.

[9] There are considerably more observations for the recent years (2013 and 2014) due to missing number of employees in earlier years. The focus on non-resources part of the economy is due to the fact that productivity is a slightly different concept for oil companies, given the time-to-build between investment phase and production phase; it also depends in large part on remaining reserves.

Impact of product market regulation

13. We measure the burden from PMR for all sectors in the Norwegian economy using input-output linkages between regulated and downstream sectors. As a measure of regulation, we use the OECD's indicators for seven network sectors, retail and professional services. Regulation in those industries can affect firms in other sectors of the economy (i.e. the downstream sectors) through their use of upstream inputs. For example, a manufacturer who relies more extensively on the use of rail and postal services would bear a heavier burden from regulation in the rail and postal services sectors, either through paying higher prices or enduring lack of or sub-optimal quality of services. We call this indirect burden from regulation *upstream PMR* and measure it by combining the PMR indicator with the intensity of upstream input usage calculated from Norway's input-output table for the year 2013 (Box 2).

14. The following empirical specification is used to investigate the correlation between upstream PMR and firm productivity:

$$Y_{ist} = \beta * UpstreamPMR_{st} + \gamma' X_{ist} + Z_t + D_s + D_r + \varepsilon_{ist}$$

Where Y_{ist} refers to the natural logarithm of firm productivity (either labor productivity or TFP), $UpstreamPMR_{st}$ denotes the indicator of upstream regulation in the downstream sector s, X_{ist} is a vector of firm-level control variables (e.g., leverage defined as the ratio of total debt to total assets and company age[10]), Z_t is the output gap to capture the economy's cyclical condition, and D_s and D_r are sector and region fixed effects. The β coefficient is expected to be negative, that is, more restrictive regulation is expected to correlate with lower firm productivity. We run the regressions by firm size class (i.e. micro, small, medium, and large) to allow for the impact of deregulation to vary across firms of different sizes.[11]

15. We also test the hypothesis that PMR has differential impacts across sectors based on their innovation intensity. We use Eurostat's taxonomy of high- and medium-technology manufacturing sectors and knowledge intensive services at the NACE 3-digit level to classify firms into two categories—`*HTKIS*' (high-tech and knowledge-intensive sector) firms and `non-*HTKIS*' firms.[12] The idea is that a higher level of product market competition would be expected to spur innovation particularly for firms in technology or knowledge intensive sectors, thereby generating larger productivity gains. To test this hypothesis, we augment the baseline specification by

[10] We classify firms across four age classes: start-ups, young, mature, and well-established (Appendix I)

[11] We classify firms into four size classes: Micro = 10 employees or fewer, Small = 11 to 50 employees, Medium = 51 to 250 employees, and Large = more than 250. Instead of running regressions by firm size class, we also try controlling for the logarithm of total assets; the results are qualitatively unchanged.

[12] Eurostat classifies manufacturing industries according to their technology intensity (based on the ratio of R&D expenditures to value added) and services according to their degree of knowledge intensity (based on the share of people with tertiary education in the activity).

interacting the *Upstream PMR* variable with the *HTKIS* indicator (which takes value of one for *HTKIS* firms and 0 for others). Thus, the δ coefficient would give the additional productivity impact of PMR on *HTKIS* firms over and above that for non-*HTKIS* firms.

$$Y_{ist} = \beta * UpstreamPMR_{st} + \delta * UpstreamPMR_{\mathrm{st}} * HTKIS + \theta * HTKIS + \gamma' X_{ist} + Z_t + D_s + D_r + \varepsilon_{ist}$$

Box 2. Measuring Indirect Regulatory Burdens

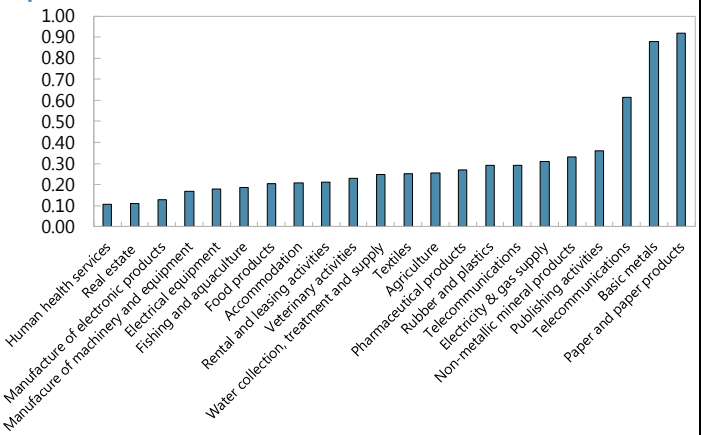
The OECD indicators of PMR are used to measure regulatory provisions in seven network sectors, retail trade and professional services covered in the analysis over the sample period. The seven network sectors include air transport, electricity, gas, post, rail, road transport, and telecom, and professional services comprise of accounting, legal, architect, and engineer). The evaluation of the network sector-specific PMRs follows a bottom up approach, aggregating data on entry regulation, public ownership, vertical integration, market structure, and price controls. Sector regulation of retail trade is assessed by compiling evaluations of six dimensions, i.e. entry regulation, restrictions on shop size, protection of existing firms, regulation of shop opening hours, price controls, and promotions or discounts. Similarly, professional services regulation is examined in two main areas of entry and conduct regulation. The scale of the PMR indicators ranges from 0 to 6, with higher values indicating more regulation. The indicators are provided on a yearly basis for network industries but they are only available every five years in 2003, 2008, and 2013 for retail trade. The regulated network sectors, retail trade, and professional services account for about 26 percent of total output in the economy.

From the Norwegian input-output table for 2013, we extract information on the use of inputs for each of the NACE Revision 2 sectors as well as their output. The variation in input usage across industries called input intensity allows us to extend the regulatory burden on network sectors, retail trade, and professional services to the entire economy, thereby capturing the indirect regulatory burden from upstream sectors on all firms. Using both the PMR indicators and input intensities, we follow Bourles and others (2013) to measure the indirect regulatory burden from regulation in upstream industries on downstream sectors. More specifically, we aggregate PMRs and input intensities (from upstream regulated sectors) for each downstream two-digit level sector as follows:

$$Upstream\ PMR_{dt} = \sum_{u=1}^{7} PMR_{ut} * Intensity_{du}$$

PMR_{ut} is the direct regulatory burden for regulated sector *u* at time *t, and* $Intensity_{du}$ refers to sector-specific input intensities of downstream sector *d* from upstream regulated sector *u,* measured as the units of regulated product *u* that are needed to produce one unit of final output in sector *d*. Thus, $UpstreamPMR_{dt}$ measures the indirect regulatory burden that the downstream sector *d* is subject to at time *t*, calculated as the weighted average of the direct regulatory burden in regulated sectors and the sector-specific input intensities. The text figure below illustrates the level of *upstream PMR* from the seven network sectors, retail trade, and professional services for selected two-digit-level downstream sectors in Norwegian economy. With varying input dependency on product in regulated sectors, the downstream sectors are subject to upstream product market regulation from the seven network sectors, retail trade, and professional services that ranges from 0.002 to 0.23.

Upstream PMR for selected sectors 1/



Sources: Statistics Norway, OECD and Fund staff calculation.
1/ Upstream PMR takes into account regulations in the seven net work industries, retail trade, and professional services.

16. Estimation results indicate that regulation in upstream sectors significantly affects firm productivity in downstream sectors. The results point to a negative and significant correlation between *upstream PMR* and firm productivity in downstream sectors, and are robust to multiple specifications and different productivity measures (Tables 1 and 2).[13] Firms operating in sectors that rely more heavily on inputs from the regulated industries are likely to be less productive than others. Our results also suggest that the impact of PMR on firm productivity varies by firm size: it is most pronounced for medium firms and least pronounced for large firms, with the impact on micro and small firms being somewhere in the middle. For example, a one standard deviation reduction in *PMR* is associated with higher TFP by over 15 percent for medium-sized firms, but only by 6 percent for large firms.[14] The magnitude of the estimated impact is similar to that in other comparable studies on productivity and PMR (see e.g. Lanau and Topalova, 2016 for Italy; Geng, Ho and Turk, 2016 for Denmark). Finally, it is worth noting that the size of the coefficients is similar for labor productivity and TFP, but the explanatory power of the regressions is higher using TFP than labor productivity as dependent variable.

17. We also find evidence that PMR affects innovation intensive firms disproportionately. The coefficient on the interaction between *Upstream PMR* and *HTKIS* dummy is negative and significant (for some size classes), indicating that *HTKIS* firms tend to bear a relatively heavier burden from anti-competitive regulation. The differential impact is again largest for the medium size class, about three times as large for *HTKIS* firms as for non-*HTKIS*. These findings are consistent with those reported for OECD countries (Nicoletti and Scarpetta, 2003; Conway and Nicoletti, 2006; Arnold, Nicoletti, and Scarpetta, 2008; Moreno-Badia, 2009).

Table 1. Effect of Upstream PMR on Downstream Labor Productivity

	Labor Productivity							
Variables	Micro	Small	Medium	Large	Micro	Small	Medium	Large
Upstream PMR	-0.175	-0.163	-0.237	-0.098	-0.139	-0.154	-0.155	-0.066
	[0.029]***	[0.032]***	[0.061]***	[0.044]**	[0.033]***	[0.037]***	[0.067]**	[0.052]
*Upstream PMR * HTKIS dummy*					-0.190	-0.055	-0.298	-0.086
					[0.071]***	[0.071]	[0.100]***	[0.101]
Observations	82,759	35,382	5,925	1,457	82,759	35,382	5,925	1,457
R-squared	0.173	0.459	0.485	0.470	0.174	0.459	0.486	0.470

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

[13] The definitions and summary statistics for the variables entering the regressions are reported in Appendix II. Tables 1 and 2 report the results for labor productivity and the Levinsohn-Petrin measure of TFP (our preferred measure), respectively. Additional results using other TFP measures are presented in Appendix III.

[14] To calculate the average effect on firm productivity from reducing *Upstream PMR*, we keep input use intensity across all sectors constant at the average level.

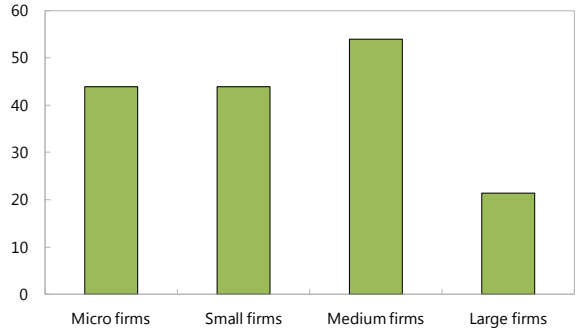
Table 2. Effect of Upstream PMR on Downstream TFP

Total Factor Productivity (LP method)								
Variables	Micro	Small	Medium	Large	Micro	Small	Medium	Large
Upstream PMR	-0.174	-0.174	-0.214	-0.085	-0.142	-0.161	-0.132	-0.069
	[0.027]***	[0.030]***	[0.060]***	[0.039]**	[0.030]***	[0.034]***	[0.067]**	[0.049]
*Upstream PMR * HTKIS dummy*					-0.173	-0.079	-0.299	-0.044
					[0.071]**	[0.068]	[0.096]***	[0.085]
Observations	79,582	35,111	5,894	1,455	79,582	35,111	5,894	1,455
R-squared	0.298	0.601	0.680	0.676	0.298	0.601	0.680	0.676

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

18. Narrowing the gap between PMR in Norway and the frontier would generate sizable windfall productivity gains. In a stylized policy experiment, we use the estimated coefficients from Table 2 to calculate the average change in steady-state firm TFP from reducing Norway's *upstream PMR* indicator such that a quarter of the distance between Norway and the frontier is closed. This would mean deregulation in *all* upstream sectors, including the seven network industries, retail, and professional services. Our calculations suggest that such deregulation would increase average firm TFP in Norway by roughly 40 percent, with greater benefits accruing to small and medium-sized firms relative to larger ones. In addition, *HTKIS* firms would record much larger productivity gains compared to non-*HTKIS* firms. Since the regulatory gaps between Norway and the best practice are particularly large in the gas and postal services sectors, these industries present more scope for deregulation than others.

Impact of Partially Closing PMR Gap between Norway and Frontier on Average Firm TFP, by Size (Percent change)



Sources: Fund staff estimates.
Note: Assuming a quarter of the gap is closed.

19. These results should be interpreted with the usual caveats. They can only be indicative of potential productivity gains from deregulation. As is well known, it is an empirical challenge to isolate the impact of any structural reform from that of other reforms that may be implemented at or around the same time. In addition, the OECD's PMR indicators—although widely used in the empirical literature—are only crude proxies for the state of regulation in any country, which makes cross-country comparison problematic. In any case, some degree of regulation in certain sectors may be justified by other policy considerations or societal preferences, which arguably makes simply lowering regulation to the level of the "best practice" somewhat of a stylized policy experiment.

Impact of R&D investment

20. The empirical specification to test the effect of R&D spending takes the following form:

$$Y_{ist} = \beta * RD_{st} + \gamma' X_{ist} + Z_t + D_s + D_r + \varepsilon_{ist}$$

where RD_{st} is the logarithm of R&D expenditure at the sector level provided by the OECD, and Y_{ist} is the log of either firm value added or productivity (TFP) (other notations remain as in the previous section). This specification can be easily derived from a Cobb-Douglas production function with R&D capital as one of the factor input. The coefficient β gives the elasticity of output or productivity with respect to R&D investment. As R&D expenditure is measured at the sector level, this elasticity could be interpreted as also capturing the positive spillover effect of the R&D spending undertaken by other firms in the same sector.[15]

21. Results indicate that R&D investment has a positive effect on firm performance (Table 3). The elasticity of value added with respect to R&D spending is estimated to be about 0.24–0.3 depending on firm size. That is, a 10 percent increase in the sector's R&D expenditure is associated with a 2.4–3 percent improvement in firm's value added. This magnitude falls in the mid-range of elasticity estimates in the literature, which range from close to 0 to about 0.5 depending on the sample and the methodology (see e.g. Congressional Budget Office, 2005 for a summary). The value added elasticity is remarkably stable across firm size, whereas the TFP elasticity is highest for medium-sized firms. Neither elasticity is statistically significant for large firms.

Table 3. Effect of R&D Spending on Firm Value Added and TFP

	Value added				TFP			
Variables	Micro	Small	Medium	Large	Micro	Small	Medium	Large
R&D spending	0.295	0.239	0.274	-0.054	0.184	0.196	0.357	0.068
	[0.058]***	[0.047]***	[0.102]***	[0.033]	[0.042]***	[0.037]***	[0.090]***	[0.156]
Observations	45,357	22,648	3,913	968	43,886	22,501	3,898	967
R-squared	0.151	0.333	0.404	0.487	0.254	0.561	0.676	0.643

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

D. Conclusion

22. There is ample scope for improving Norway's productivity performance. The deterioration in productivity growth over the past decade has several structural components (e.g., Dutch disease, immigration) that can only be gradually unwound. Moreover, Norway's well-developed policy and institutional framework implies that low-hanging fruits are limited. Nevertheless, our analysis, which focuses on product market regulation and research/innovation,

[15] The Orbis database also collects information on the firm's R&D spending; however, this variable has many missing values and thus cannot be used in the analysis.

find some evidence of the potential for productivity gains in those areas. In particular, relaxing the existing constraints in the product market (e.g., state ownership and other barriers to entry in certain sectors) and boosting (both the quantity and quality of) R&D spending are found to associate with higher firm productivity, with larger impact on high-tech and knowledge-intensive firms—the building blocks of the "new economy." Our quantitative perspective supports the recommendations by the Productivity Commission, and highlights the urgency and importance of building a dynamic and productive private sector in the Norwegian mainland economy that will ultimately need to replace natural resources as the main engine of growth.

Appendix I. Data Sample and Cleaning Procedure

Our sample includes all firms for which key variables are provided, including value added and the number of employees. Our data comes from the commercial Orbis database provided by Bureau Van Dijk. We retrieve the universe of firm-level data available over the period 2005–14, resulting in a total of 727,669 firm-year observations. We select unconsolidated financial statements of companies where available and consolidated statements otherwise, excluding subsidiaries to avoid double-counting. The firms are distributed geographically across 436 regions in Norway, including Nord-NorgeNordlandBodo, Nord-NorgeTromsTromso, Nord-OstlandetAkershusAsker, Nord-OstlandetAkershusBarum, OstlandetAkershusSkedsmo, OstlandetOsloOslo, OstlandetOstfoldFredrikstad, SorlandetVest-AgderKristiansand, TrondelagSor-TrondelagTrondheim, VestlandetHordalandBergen, VestlandetMore og RomsdalAlesund, VestlandetRogalandSandnes, VestlandetRogalandStavanger.

A number of filtering rules are applied to the original sample. Following the literature, we exclude all firms in the mining and quarrying industry (to focus on the non-oil economy), financial services industry (where high leverage is not an indication of distress and liquidity is held to meet regulatory requirements and not to undertake positive net present value investment projects) and in public administration and defense (Fama and French, 1992; Bates and others, 2009). We also delete observations with negative values for key variables of interest- such as current assets, fixed assets, total assets, leverage, shareholder funds, sales, and cost of employees; we drop the bottom and top 5 percent of the distribution of return on assets and return on equity. Our final sample includes 80,474 firms distributed across 17 major sectors employing close to 1.4 million workers. The majority of firms belongs to wholesale and retail trade, followed by construction, manufacturing, professional services, and information and communication sectors.

The majority of firms in Norway are very small privately-held firms. We group firms in different size categories using the number of employees. Micro firm employ less than 10 employees (69 percent of the sample), firms with employees less than 50 but more than 10 are labeled as small (26 percent of total), medium firm have between 50 and 250 employees (4 percent of total), and above that are large firms (1 percent). The overwhelming majority of firms (99.7 percent), suggesting that focusing on large or listed firms only is likely to provide an incomplete picture of economic activity in Norway. Also, 84 percent of firms are active, and the rest is either dissolved or in liquidation. We keep both active and inactive firms in our sample to capture the dynamics of the market in terms of not just entry but also exit.

Firms of different size have different asset composition and funding structure. In Norway, small firms invest much less in fixed assets than medium and large firms and a higher fraction of their assets is kept liquid. On the funding sources, small firms rely more on equity than debt financing. Noteworthy is that profitability indicators are greater for small than for large firms. Finally, 17 percent of firms in our sample are start-ups (established less than 5 years ago), 40 percent are young (between 5 and 10 years of operations), 42 percent are mature (between 10 and 35 years of age), and the remaining 1 percent have been in the market for more than 35 years.

Table A1.1. Firm Distribution, Value Added, and Employment across Sectors

Sector of Economic Activity	Number of firms	Value Added Share	Employment Share
A - Agriculture, forestry and fishing	1,545	2.3	1.4
B - Mining and quarrying	417	9.2	2.6
C - Manufacturing	7,043	17.0	15.9
D- Electricity, gas, steam and air cond.	393	4.1	0.9
E- Water supply; sewerage, waste managmt	433	0.8	0.7
F - Construction	15,312	9.4	11.4
G- Wholesale and retail trade; repair	20,902	15.1	20.2
H - Transportation and storage	4,471	9.0	8.0
I- Accommodation and food service activ.	3,571	1.4	3.2
J - Information and communication	3,414	7.9	5.6
L - Real estate activities	202	0.1	0.0
M- Professional, scientific and technical	8,893	6.7	5.7
N- Administrative and support service	3,628	4.1	6.2
P - Education	1,321	0.7	1.1
Q- Human health and social work activit.	4,865	10.4	14.3
R - Arts, entertainment and recreation	1,594	0.7	1.1
S - Other service activities	2,470	1.2	1.6
Total	*80,474*	100	100

Table A1.2. Asset Composition, Funding Structure, and Profitability across Firm Size

Firm Size	Current Assets / Total Assets	Fixed Assets / Total Assets	Total Debt / Total Assets	Total Equity / Total Assets	Return on Assets	Return on Equity
Micro	81.1	18.9	63.6	36.4	8.0	24.2
Obs.	*84,795*	*84,795*	*84,795*	*84,795*	*84,795*	*84,795*
Small	80.1	19.9	68.8	31.2	8.3	27.2
Obs.	*35,645*	*35,645*	*35,645*	*35,645*	*35,645*	*35,645*
Medium	73.0	27.0	69.6	30.4	6.7	21.8
Obs.	*6,109*	*6,109*	*6,109*	*6,109*	*6,109*	*6,109*
Large	56.4	43.6	68.8	31.2	5.8	17.3
Obs.	*1,566*	*1,566*	*1,566*	*1,566*	*1,566*	*1,566*
All	80.2	19.8	65.8	34.2	8.0	24.8
	128,115	*128,115*	*128,115*	*128,115*	*128,115*	*128,115*

Appendix II. Variables Definition and Key Descriptive Statistics

Description and sources of all variables entering the regressions appear in Table A2.1.

Table A2.1. Variables Definition and Sources

Variable	Description	Source
Labor Productivity	Real value added per employee	Orbis and authors' calculations
TFP - Solow residual	Solow residual (Box 3)	Orbis and authors' calculations
TFP - OLS	OLS residual (Box 3)	Orbis and authors' calculations
TFP - Levinsohn-Petrin	Levinsohn-Petrin residual (Box 3)	Orbis and authors' calculations
Product Market Regulation (PMR)	PMR: Network, Retail, and Professional Services	OECD and authors' calculations
Upstream PMR	Cross-product of PMR and input intensity	OECD, Statistics Norway, and authors' calculations
Upstream PMR - HTKIS	Cross-product of PMR, input intensity, and high tech and knowledge intensive sectors	OECD, Statistics Norway, and authors' calculations
R & D	Gross domestic expenditure on R&D	OECD, Statistics Norway,
Firm Leverage	Debt to total assets	Orbis and authors' calculations
Output Gap	Output gap as a percent of potential GDP	WEO database

Summary statistics on the key variables entering the empirical specification appear in Table A2.2. Since we keep both active and inactive or dissolved firms, the latter typically may have negative equity and hence the debt-to-assets ratio that exceeds 100 percent.

Table A2.2. Descriptive Statistics for Variables Entering the Regressions

Variable	Obs	Mean	Std. Dev.	Min	Max
Labor Productivity	126,599	10.7	0.8	3.6	19.0
TFP - Solow residual	123,107	8.1	1.6	-4.7	16.3
TFP - OLS	123,107	9.4	0.8	1.5	16.3
TFP - Levinsohn-Petrin	123,107	10.5	0.9	3.2	18.3
Upstream PMR	127,014	19.0	8.0	4.6	94.4
Upstream PMR - HTKIS	127,014	4.9	9.0	0.0	62.6
R&D	62,899	18.4	0.9	14.6	20.1
Firm Leverage	128,115	63.8	25.5	0.0	149.0
Output Gap	128,115	0.0	0.4	-1.3	2.3

[1] *Labor Poductivity, TFP, and R&D* variables are in logs;
Upstream PMR , *Firm Leverage* , and *Output Gap* variables are in percent.

Appendix III. Additional Results

The results for upstream PMR are robust to using alternative productivity measures. In addition to the results for labor productivity and the Levinsohn-Petrin measure of TFP reported in the text, we test the sensitivity of our results to using two alternative TFP measures (described in Box 2). The baseline results hold in both robustness checks (Tables A3.1 and A3.2).

Table A3.1. Effect of Upstream PMR on TFP—Solow Residual

	Total Factor Productivity (Sollow residual)							
Variables	Micro	Small	Medium	Large	Micro	Small	Medium	Large
Upstream PMR	-0.493	-0.511	-0.488	-0.448	-0.432	-0.461	-0.284	-0.297
	[0.059]***	[0.058]***	[0.099]***	[0.091]***	[0.071]***	[0.066]***	[0.110]***	[0.090]***
*Upstream PMR **					-0.322	-0.300	-0.744	-0.411
					[0.112]***	[0.119]**	[0.161]***	[0.198]**
Observation	79,582	35,111	5,894	1,455	79,582	35,111	5,894	1,455
R-squared	0.717	0.826	0.847	0.774	0.717	0.826	0.848	0.775

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A3.2. Effect of Upstream PMR on TFP—OLS

	Total Factor Productivity (OLS)							
Variables	Micro	Small	Medium	Large	Micro	Small	Medium	Large
Upstream PMR	-0.166	-0.184	-0.223	-0.078	-0.137	-0.172	-0.138	-0.052
	[0.025]***	[0.028]***	[0.061]***	[0.041]*	[0.028]***	[0.031]***	[0.067]**	[0.050]
*Upstream PMR **					-0.156	-0.074	-0.310	-0.070
					[0.068]**	[0.067]	[0.097]***	[0.092]
Observation	79,582	35,111	5,894	1,455	79,582	35,111	5,894	1,455
R-squared	0.314	0.537	0.506	0.640	0.314	0.537	0.507	0.640

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

References

Aghion P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt, 2005, "Competition and Innovation: An Inverted-U Relationship," *The Quarterly Journal of Economics,* Vol. 120, No. 2, pp. 701-728.

Aghion, P., and P. Howitt, 2005, "Appropriate Growth Policy: A Unifying Framework," 2005 Joseph Schumpeter Lecture, 20th Annual Congress of the European Economic Association, Amsterdam, August 25.

Arnold, J., G. Nicoletti, and S. Scarpetta, 2008, "Regulation, Allocative Efficiency, and Productivity in OECD Countries: Industry and Firm-level Evidence," OECD Economics Department Working Papers No. 616, (Paris: Organization for Economic Cooperation and Development).

Arnold, J., B. Javorcik, Lipscomb, and A. Mattoo, 2011, "Does service liberalization benefit manufacturing firms? Evidence from the Czech Republic," *Journal of International Economics* 85(1)

Barone, G. and F. Cingano, 2011, "Service Regulation and Growth: Evidence from OECD Countries," *The Economic Journal* 121(555), 931–957.

Bourlès, R., G. Cette, J. Lopez, J. Mairesse, and G. Nicoletti, 2013, "Do product market regulations in upstream sectors curb productivity growth? Panel data evidence from OECD countries," *The Review of Economics and Statistics* 95(5).

Conway, P., and G. Nicoletti, 2006, "Product Market Regulation in the Non-Manufacturing Sectors of OECD Countries: Measurement and Highlights," OECD Economics Department Working Paper No. 530 (Paris: Organization for Economic Cooperation and Development).

Correa-López, M. and R. Doménech, 2014, "Does anti-competitive service sector regulation harm exporters? Evidence from manufacturing firms in Spain," BBVA Research, Working Paper, Nº 14/13, Spain.

Congressional Budget Office, 2005, "R&D and Productivity Growth," Background Paper, June 2005.

Cornell University, INSEAD, and World International Property Organization, 2015, *The Global Innovation Index 2015: Effective Innovation Policies for Development*, Fontainebleau, Ithaca, and Geneva.

Forlani, E., 2012, "Competition in Services and Efficiency of Manufacturing Firms: Does 'Liberalization' Matter?," Katholieke Universiteit Leuven, LICOS Discussion Paper No. 311/2012.

Geng, N., G. Ho, and R. Turk, 2016, "Product Market Reform and Productivity in Denmark," IMF Selected Issues Papers, Chapter 4, *forthcoming,* Washington DC.

Lanau, S. and P. Topalova, 2016, **"**Product Market Reforms and Firm Performance: Evidence from Italy," IMF WP 16/XX, International Monetary Fund, Washington DC, *forthcoming*.

Moreno-Badia, Marialuz, 2009, "Productivity Growth and Structural Reforms", IMF Selected Issues Papers, Chapter 4, Washington DC.

Ministry of Finance, 2016, "National Budget 2016."

Ministry of Finance, 2016, "Revised National Budget 2016."

Nicoletti, G., and S. Scarpetta, 2003, "Regulation, Productivity, and Growth: OECD Evidence," Economy Policy, Vol. 18 (April), pp. 9–72.

Productivity Commission, 2016, Second-phase Report (in Norwegian).

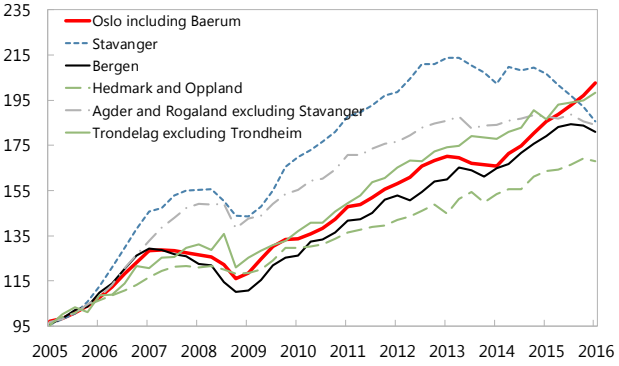
THE HOUSING BOOM AND MACROPRUDENTIAL POLICY[1]

The high and rising house prices and household debt in Norway pose important financial stability risks. To address these systemic risks, the authorities have implemented a number of macroprudential policy measures. This paper empirically assesses the effectiveness of the housing-related measures in the Norwegian context, controlling for other variables that affect house prices and mortgage credit growth. Additionally, a DSGE model is used to examine the potential impact of tightening certain policies.

A. The Norwegian Housing Market and Household Debt

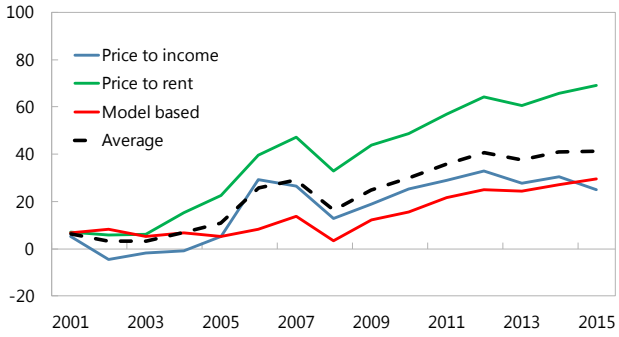
1. Norwegian house prices have risen substantially over the past 15 years. Since 2000, nominal house prices have risen more than 140 percent (more than 80 percent after adjusting for CPI inflation), with average annual house price growth of 9.3 percent from 2000–07 and 4.6 percent since 2008. The increase was even larger in oil-dependent regions and cities such as Stavanger, where prices more than doubled between 2005 and their peak in 2013. The rise in house prices has also been geographically widespread, with prices rising by 70 percent or more in different regions since 2005. Recently, house price inflation slowed during 2015, but accelerated again in some regions in early 2016. Developments have diverged across regions. In the Oslo area and in central Norway prices have continued rising robustly. In Stavanger, where the sizable drop in oil prices since 2013 has had a significant impact, including on unemployment, house prices have begun to decline from very high levels. Nationwide, house price overvaluation is estimated at 40 percent at end-2015 (based on the average of three different standard valuation measures).[2]

Regional House Prices
(SA Index: 2005=100)



Sources: Statistics Norway and Fund staff calculations.

Estimated House Price Valuation Gaps in Norway
(Percent)



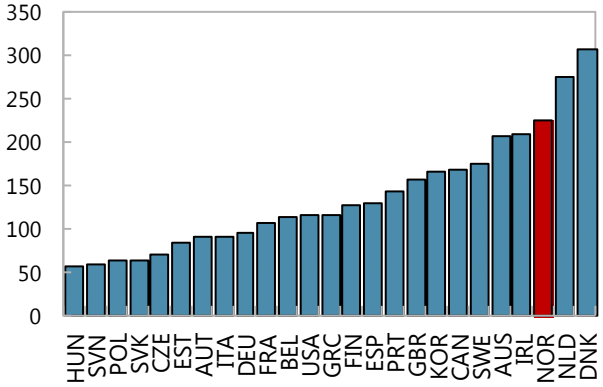
Sources: OECD and Fund staff calculations.
Note: The model is described in the 2013 Nordic Regional Report and 2013 Norway Article IV Selected Issues.

[1] Prepared by Nathaniel Arnold and Nan Geng. We would like to thank Jiaqian Chen for assistance with the calibration of the DSGE model based on Chen and Columba (2016).

[2] Though it is a standard measure of overvaluation, the price-to-rent ratio may be a less useful measure in Norway's case, where the rental market is small, and overstate the degree of overvaluation.

2. Households' indebtedness has risen along with house prices. Households' debt level has risen from around 145 percent of disposable income in 2002 to over 220 percent in 2015, higher than in most comparator countries. This has been primarily driven by debt rising much faster than incomes, especially before the 2008–09 global financial crisis (GFC). Households' debt growth averaged 12 percent per year before the GFC, and, while it has slowed, it has averaged 7 percent annually since then. Over the same period, annual disposable income growth averaged slightly more than 5 percent.

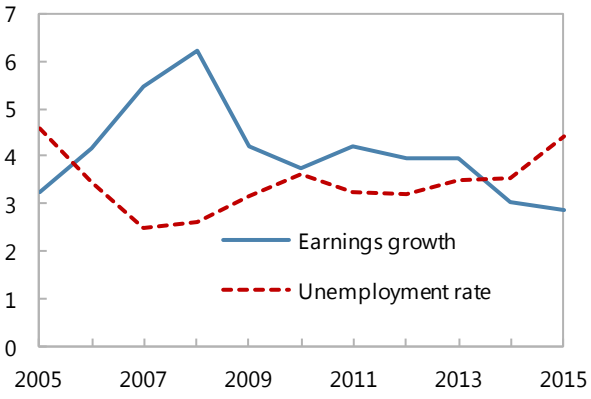
Household Debt
(Percent of disposable income, 2014)



Sources: OECD and Fund staff calculations.

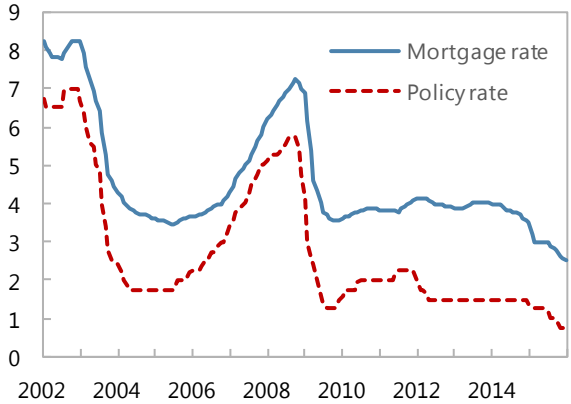
3. Low unemployment, robust income growth, and declining mortgage rates have contributed to housing demand. Unemployment in Norway has remained relatively low, even following the GFC, which increased housing demand pressures. In particular, until 2014, high oil prices helped keep unemployment down, especially in oil dependent areas such as Stavanger. Housing demand has also been fueled by declining mortgage rates, with real mortgage rates down substantially since 2002 and falling close to zero by end-2015.

Earnings Growth and Unemployment Rate
(Percent and percent of labor force)



Sources: Statistics Norway and Fund staff calculations.

Interest Rates
(Percent)



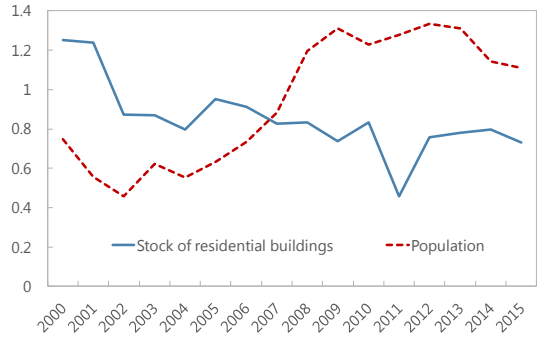
Sources: Statistics Norway, Norges Bank, and Fund staff.

4. Structural factors have also contributed to high and rising house prices and household indebtedness (Figure 1). Population growth and increasing urbanization—with average population growth over 1.2 percent since 2008 and an average annual urbanization rate of 1.4 percent over 2010–15 according to the CIA World Fact Book—are increasing the demand for housing in the main urban areas. At the same time, restrictions on development and minimum unit size have constrained the responsiveness of the housing supply, driving up prices. Also, there are a number of tax incentives for home ownership and mortgage financing. Compared with other assets,

Figure 1. Structural Factors Contributing to the Housing Boom

Population and Housing Stock, 2000-15

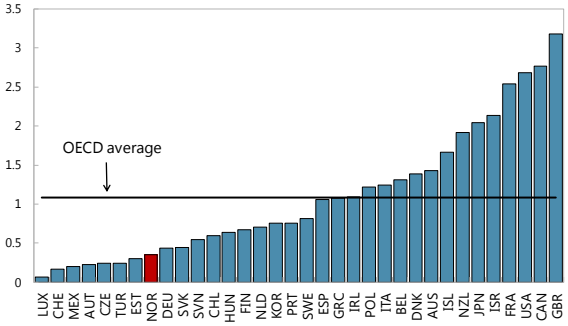
(Annual growth, in percent)



Sources: Statistics Norway and Fund staff calculations.

Property tax revenue, 2013

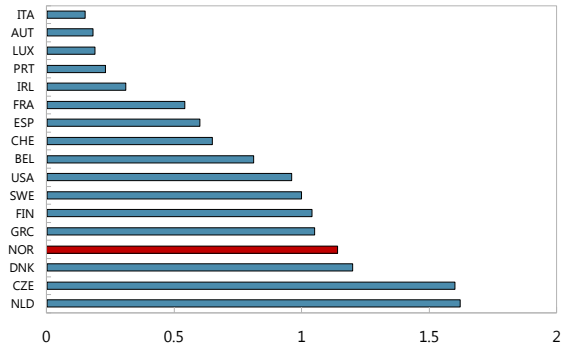
(Percent of GDP)



Sources: OECD and Fund staff calculations.
Note: Revenue from "recurrent taxes on immovable property."

Tax Relief for Housing Finance

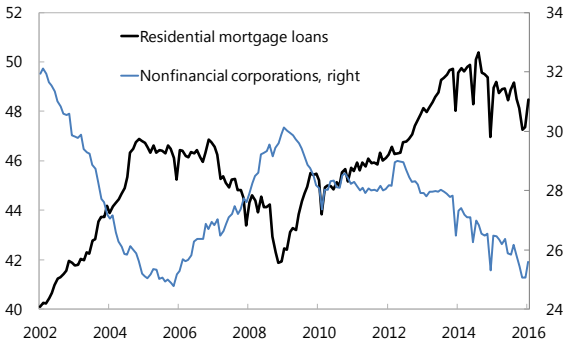
(Tax wedge, increasing in degree of tax relief)



Sources: OECD and Fund staff calculations.

Structure of Credit

(Percent of total loans extended by banks and mortgage companies)



Sources: Statistics Norway and Fund staff calculations.

owner-occupied housing enjoys a large discount in tax base calculation for wealth taxation (25 percent of market value for primary dwellings and 80 percent for secondary dwellings). Interest on mortgages is tax deductible, which effectively reduces the debt service costs, thereby incentivizing households to borrow more (IMF, 2013a). Finally, lower risk-weights for housing loans compared to corporate loans have caused banks to shift their loan portfolios towards mortgage lending.

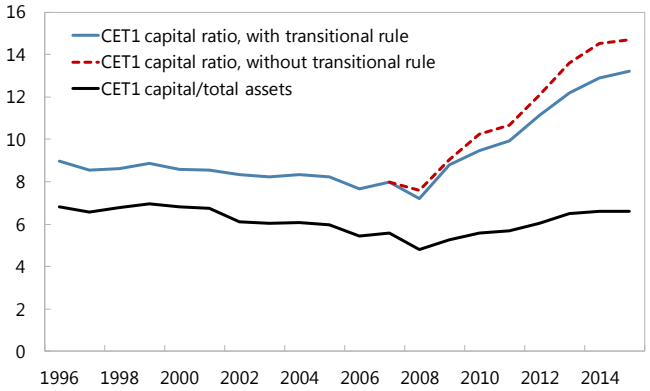
5. Overvalued house prices and elevated household debt levels can create systemic macro-financial risks. If house prices substantially exceed fundamentals, this increases the risk of a house price correction. The direct effect on default rates would probably be limited due to households' financial buffers, the social safety net, and because mortgages are full recourse loans. However, a decline in house prices would weigh on households' consumption (e.g., due to wealth effects), which would negatively impact output and non-financial corporates (NFCs), as well as increasing unemployment. A downturn would likely increase NFCs defaults on loans, especially loans to real estate developers, which would impair banks' balance sheets.

B. Macroprudential Policy Developments

6. Norway has implemented additional capital buffer requirements for banks. In particular, the national legislation based on CRDIV and CRR introduced a countercyclical capital buffer (CCB), a systemic risk buffer (SRB) set at 3 percent of risk weighted assets (RWA) for all banks, and an additional capital buffer for domestically systemically important institutions (D-SIIs). Three financial institutions have been designated D-SIIs and will have to hold additional capital worth 2 percent of RWA from July 1, 2016. The CCB was also activated, which required banks to have additional capital worth 1 percent of RWA by mid-2015, and it will be increased to 1.5 percent of RWA by end-June 2016.

7. While increasing capital buffers strengthens banks' resilience, some of the improvement in regulatory capital ratios was due to changes in risk weighted assets. Following the introduction of Basel II standards in 2007, banks using the internal ratings based (IRB) approach lowered risk weights on mortgages markedly. Banks also shifted the composition of their loan portfolios towards mortgages, which typically have lower risk weights than corporate loans. As a result, regulatory capital ratios (CET1 capital over RWA) improved much more than the simple leverage ratio (CET1 capital over total assets).[3]

Tier 1 Capital Ratios
(Percent)



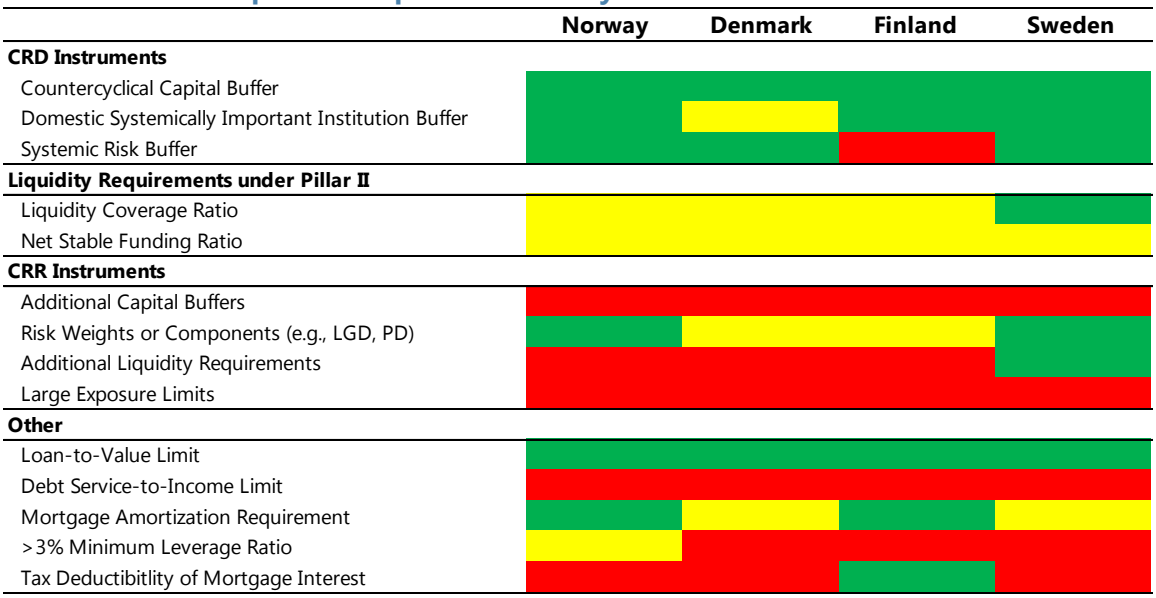
Sources: Norges Bank and Fund staff calculations.

8. This eventually prompted the FSA to tighten constraints on how banks using the IRB approach calculate risk weights for mortgage loans. Both the loss given default (LGD) and probability of default (PD) parameters of the IRB models were raised in 2014–15. Effectively, this pushed up average risk weights on residential mortgages from around 10 percent to around 20–25 percent. Additionally, the Norwegian authorities obtained the cooperation of the Danish and Swedish regulators in applying these changes to risk weight calculations for mortgage loans made in Norway by branches of Danish and Swedish banks operating there.

9. The authorities also introduced measures specifically targeted at containing mortgage credit growth (also see Appendix I). They include a maximum loan-to-value (LTV) ratio, an affordability test, and an amortization requirement for loans with an LTV ratio above 70 percent. These measures had been introduced as guidelines in March 2010 and then converted into

[3] The gap between the regulatory capital ratio and simple leverage ratio would have been wider without the transitional rule. Under the transitional rule in Basel II, an IRB bank's total risk-weighted assets could not be lower than a given percentage rate of what is would have been under Basel I. The limit was 95 percent in 2007, 90 percent in 2008, and 80 percent since 2009. See 2013 Financial Stability Report by the Norges Bank for more details.

Heatmap of Macroprudential Policy Measures in Nordic Countries



Source: Fund staff.

Note: Green indicates implemented; yellow indicates legislated or planned, but not yet fully implemented; red indicates no measure currently planned.

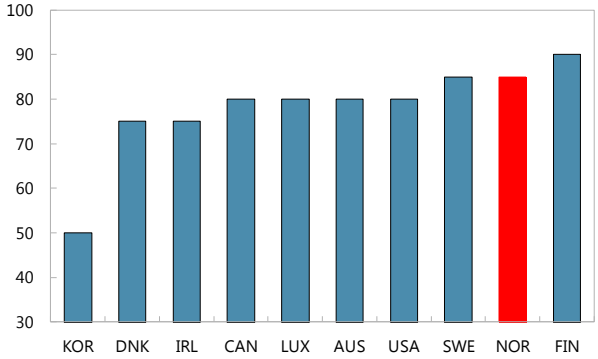
regulations in mid-2015. The LTV ratio guideline had been set at 90 percent in March 2010, before being lowered to 85 percent in December 2011, and then made a stricter requirement at the 85 percent level in mid-2015. The affordability test requires that borrowers have the capacity to service the debt in the event of a 5 percentage point increase in interest rates, since more than 90 percent of mortgages are variable rate loans. The last requirement is that annual amortization payments worth 2.5 percent of the principal be made on loans where the LTV ratio is above 70 percent.

10. However, there is some leeway in the implementation of these measures. In particular, the LTV ratio requirement can be satisfied with additional collateral or "other guarantees," which means a loan can *de facto* be larger than 85 percent of the house it's being used to purchase. Also, up to 10 percent of the value of new lending each quarter does not have to satisfy these conditions.

11. Norway's macroprudential policy toolkit is one of the most developed amongst the Nordics, but in some areas it is less ambitious. Currently at 85 percent, the LTV limit is relatively high compared with peers. In the absence of a standard debt-to-income (DTI) or debt service-to-income (DSTI) ratio limit, a financial accelerator mechanism can lead to a positive two-way feedback between credit growth and house price inflation due to the procyclicality of LTV limits, which allow lending to grow more quickly as house price increases accelerate. In addition, the new liquidity

Limits on LTV Ratios

(Percent)



Sources: Fund staff calculations.

coverage ratio (LCR) rule adopted late last year does not include a separate krone LCR requirement. Similar to Norway's banks, Sweden's banks rely on substantial foreign currency wholesale funding, so the Swedish authorities have implemented additional LCR requirements for different currencies (i.e., for krone, dollars, and euros separately). However, implementing such a measure in Norway is complicated by the fact that currently there are not enough domestic currency denominated high quality liquid assets for Norwegian banks to satisfy a krone LCR of 100 percent.

12. Structural policies can complement macroprudential policies. As noted above tax deductibility of mortgage interest is a key structural factor contributing to high household debt in Norway. Finland provides an example of a country that is gradually eliminating the tax deductibility of mortgage interest, reducing the share of the mortgage interest that can be deducted at the capital income tax rate by 10 percent per year until 2019. This Finnish experience could provide a useful case study for other Nordic countries considering a similar reduction. Additionally, relaxing planning and building restrictions could reduce supply constraints and house price growth.

C. Effects of Macroprudential Tools on Credit and House Price Growth

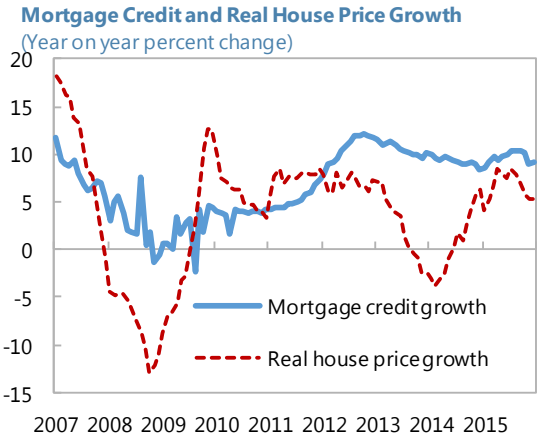
13. Evidence from other countries and cross-country studies suggest that macroprudential tools have been effective in containing credit and housing booms. Several studies have found that an increase of risk weights on a specific targeted segment of consumer loans was effective in limiting growth of that type of loans in Australia (Bank of England, 2014) and Brazil (IMF, 2013b), as well as in cross-country evidence (Arregui and others, 2013). In addition, a number of studies have found that a tightening of LTV and DTI (or DSTI) ratios is associated with a decline in mortgage lending growth, thereby reducing the risk of the emergence of a housing bubble.[4] However, there is less evidence on the simultaneous use of these tools in a specific country setting, and so far no studies have focused on the impact of these macroprudential tools specifically for Norway.

14. To gauge the impact of existing macroprudential measures, we estimate an empirical model with two separate equations for mortgage credit and house prices. A careful assessment of the effectiveness of macroprudential measures requires controlling for the economic environment in which they were taken. While the measures may not have led to an observable significant slowdown in house prices and credit growth, they may have been successful in preventing an even stronger increase. Following Krznar and Morsink (2014), we assess the effectiveness of housing-related macroprudential tools controlling for other factors using two separate equations for mortgage credit and house prices:

$$Y_t = \alpha + \beta X_t + \gamma P_t + \varepsilon_t$$

[4] These studies include individual country case studies (e.g., Igan and Kang (2011) on Korea, Wong et al. (2011) on Hong Kong, Crowe and others (2013) on U.S., RBNZ (2014) on New Zealand, Krznar and Morsink (2014) on Canada) as well as cross-country studies (e.g. Ahuja and Nabar (2011), Lim and others (2011), Kuttner and Shim (2013), Cerutti and others (2015)).

The empirical model relates the year-on-year growth rates of mortgage credit or house price (Y_t) to a matrix of control variables (X_t, either current or lagged), and a vector of macroprudential policy tools that have been put in place (in the mortgage credit equations, P_t). The mortgage credit equation includes mortgage rate, unemployment rate, house price growth, a global risk aversion variable proxied by the VIX index, consumer confidence in house purchase, and oil price growth. In addition, several variables on the supply side are included, such as construction output growth and annual change in banks' funding cost. In the house price equation we include: (i) demand factors, such as mortgage credit growth, population growth, consumer confidence in house purchase, and income growth; (ii) supply factor, such as the growth rates of number of completed houses and transfer of dwellings; and (iii) a measure of market tightness, i.e., turnover time.



Sources: Statistics Norway and Fund staff calculations.

15. The mortgage credit equation includes measures of two macroprudential policy tools. There are no macroprudential variables in the house price equation since it is assumed that macroprudential measures affect house prices indirectly through the mortgage credit. The two existing policy instruments added to the baseline specification to assess their impact are mortgage risks weights on the supply side and LTV limits on the demand side.[5] Information on banks' planned changes in LTV limits (with lags) applied to customers from the Norges Bank Lending Survey is used as proxy for the LTV policy instrument given that: (i) the date the measure was put in place may deviate from the actual time of implementation given that the LTV limits existed as a guideline until July 2015; (ii) macroprudential measures can affect credit growth with delays.[6] All the variables are (or after interpolation) at monthly frequency in a sample from 2007M8 to end-2015 (see Appendix II for definition and sources of variables).[7] To correct potential serial correlation and heteroscedasticity in the error terms, the Newey-West estimator is used.

16. The estimation results suggest a significant role of mortgage risk weights and LTV limits, among other factors, in shaping developments in mortgage credit (Table 1). Responses of mortgage credit growth to control variables mostly behave as expected (column (1)). The significance of most coefficients and the fit of the model improve after the inclusion of policy

[5] Unlike Krznar and Morsink (2014), we do not use dummies for the months following implementation of macroprudential measures, since most of the recent measures were only made binding in mid-2015.

[6] Negative net percentage balances for maximum LTV ratio denote tighter credit standards.

[7] The sample is constrained by the availability of data on banks' funding costs, mortgage risk weights, and the Norges Bank Lending Survey.

instruments (columns (2) and (3)). In particular, higher mortgage interest rates, banks' funding costs, and mortgage risk weights are associated with slower mortgage credit growth. A 10 percentage point increase in mortgage risk weights is estimated to significantly reduce mortgage credit growth

Table 1. Mortgage Credit Growth and Macroprudential Tools

Variables	(1) Baseline	(2) Risk Weights	(3) Risk Weights & LTV
Mortgage lending rate (lag)	-1.329	-1.124	-0.723
	[0.227]***	[0.255]***	[0.452]
Unemployment rate (lag)	-3.065	-2.920	-2.611
	[0.828]***	[0.864]***	[0.602]***
House price growth (lag)	0.078	0.134	0.196
	[0.066]	[0.060]**	[0.070]***
Ln(VIX) (lag)	-1.055	-1.722	-1.266
	[0.573]*	[0.568]***	[0.834]
Ln(Consumer confidence index) (lag)	1.695	3.086	2.665
	[0.822]**	[0.528]***	[0.631]***
Oil price growth (lag)	-0.023	-0.034	-0.038
	[0.006]***	[0.007]***	[0.007]***
Construction output growth (lag)	0.427	0.361	0.413
	[0.067]***	[0.033]***	[0.042]***
Banks' funding cost growth (lag)	-1.705	-1.391	-1.254
	[0.449]***	[0.494]***	[0.550]**
Mortgage risk weight (lag)		-0.242	-0.236
		[0.093]**	[0.083]***
Banks' net tightening of LTV limits (lag 1)			0.008
			[0.038]
Banks' net tightening of LTV limits (lag 2)			0.011
			[0.020]
Banks' net tightening of LTV limits (lag 3)			0.040
			[0.016]**
Constant	19.097	20.536	17.298
	[2.820]***	[2.641]***	[4.378]***
Observations	99	97	91
Centered R^2	0.802	0.811	0.829

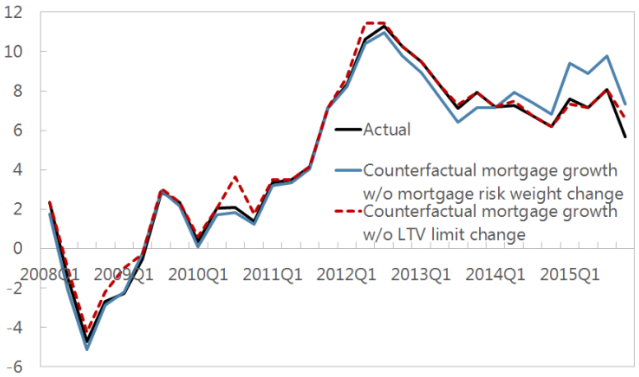
Source: Fund staff calculations.

Note: Dependent variable is mortgage credit growth (year-on-year). Significance at 1, 5, and 10 percent levels indicated by ***, **, and *, respectively. Newey-West consistent variance estimator is used to calculate the coeffcients' standard errors, which are reported in brackets below the coefficient estimates.

by 2.4 percentage points. Tightening of LTV limits start to have a statistically significant dampening impact on mortgage growth only after several months. A ten point change in the net balance measure of banks' tightening of their LTV limits over the next 3 months would reduce mortgage credit growth by 0.6 percentage points. The estimated parameters are used to calculate counterfactuals for mortgage credit growth without changes in mortgage risk weights or LTV limits, which show that credit growth would have been substantially higher recently without the rise in risk weights.

Mortgage Credit Growth, with and without Policy Changes

(Percent)



Sources: Statistics Norway and Fund staff calculations.

17. Through their impact on mortgage credit growth, macroprudential instruments can also affect how quickly house prices grow (Table 2). Mortgage credit growth has a positive and

Table 2. House Price Growth

Variables	Real House Price Growth
Mortgage credit growth (lag)	0.405
	[0.195]**
Construction output growth (lag)	-0.611
	[0.191]***
Transfers of dwellings growth (lag)	0.332
	[0.053]***
Ln(Consumer confidence index) (lag)	7.288
	[1.568]***
Turnover time (lag)	-0.073
	[0.135]
Population growth (lag 12)	12.389
	[4.065]***
Real average yearly earning growth	0.917
	[0.428]**
Constant	-27.360
	[10.485]**
Observations	93
Centered R^2	0.8805

Source: Fund staff calculations

Note. Dependent variable is real house price growth (year-on-year). Significance at 1, 5, and 10 percent levels indicated by ***, **, and *, respectively. Newey-West consistent variance estimator is used to calculate the coeffcients' standard errors, which are reported in brackets below the coefficient estimates.

significant impact on the growth of house prices. Hence, tightening a macroprudential instrument such that it slows mortgage credit growth would also translate into lower house price inflation. For instance, a 10 percentage point increase in mortgage risk weights would reduce house price growth by 1 percentage point. In addition, the negative and significant coefficient on construction output growth suggests that measures to increase the supply of housing, such as streamlining the development process, can help to rein in house price growth.

D. Potential Impact of Tightening Macroprudential Policy

18. Given data limitations, we also examine the potential impact of tightening macroprudential policy using a version of the DSGE model from Chen and Columba (2016). The model is (roughly) calibrated to the Norwegian economy. Values for most standard parameters are taken from the Norges Bank's NEMO model (Brubakk and others, 2006). Other parameters are calibrated such that the steady state of the model approximates key moments of the data (averaged over 10 years), including the household debt to disposable income ratio, which is the primary variable we focus on in the analysis of the impact of macroprudential policies. Appendix III contains details of key calibrated parameters and steady state ratios. Even though the model has been roughly calibrated to the Norwegian economy, the results should be taken as illustrative.

19. Policy changes in the LTV ratio cap, amortization requirement, and mortgage interest tax deductibility are examined. For the LTV limit, we look at the impact of a 5 percentage point reduction in the maximum LTV ratio (with the reduction occurring over 3 years). For tightening the amortization requirements, we increase the required amortization of the mortgage (over the course of 4 years) such that it reduces the maturity of new mortgages by 5 years. For the tax deductibility of mortgage interest, we model reducing the tax rate at which mortgage interest can be deducted by half (over the course of 10 years), which entails a 14 percentage point reduction in the tax rate.[8]

20. While tightening all of the macroprudential tools lowers the debt-to-income (DTI) ratio, there are differences in the size and timing of the impact. The upper chart in Figure 2 illustrates the impact on households' DTI ratio from tightening the different instruments after 5 years and in the new steady state. The tightening of both the LTV cap and amortization requirement causes a reduction in the DTI of nearly 20 percentage points in the new steady state. However, the tightening of the LTV cap achieves almost half of the steady state impact on the DTI ratio in the first 5 years, while the tightening of the amortization requirement achieves less than one-third of the steady state impact in the first 5 years. Reducing the tax deductibility of mortgage interest by half over 10 years ends up having less of an impact on the steady state DTI ratio, at just over 11 percentage points, than tightening the LTV cap or amortization requirement. However, the reduction in tax deductibility achieves almost all of its steady state impact in the first 5 years. This is because households adjust their borrowing behavior to be consistent with the effective debt service

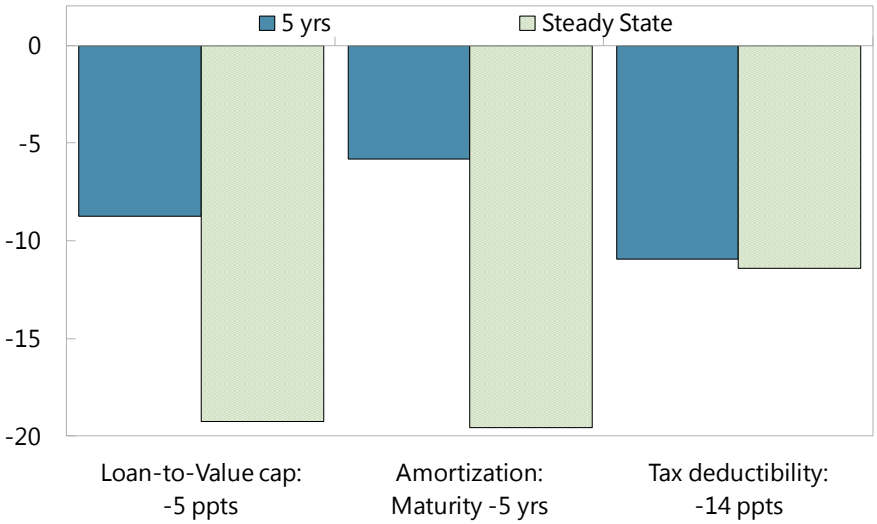
[8] While the tax deductibility of mortgage interest is technically not a macroprudential tool, it influences how much households borrow, so it is interesting to compare changes in tax deductibility to other macroprudential instruments.

Figure 2. Impact of Tightening Macroprudential Instruments

Tightening policy instruments can significantly lower the debt-to-income ratio over the medium- to long-term…

Impact on Households' Debt-to-Income Ratio

(Percentage points)

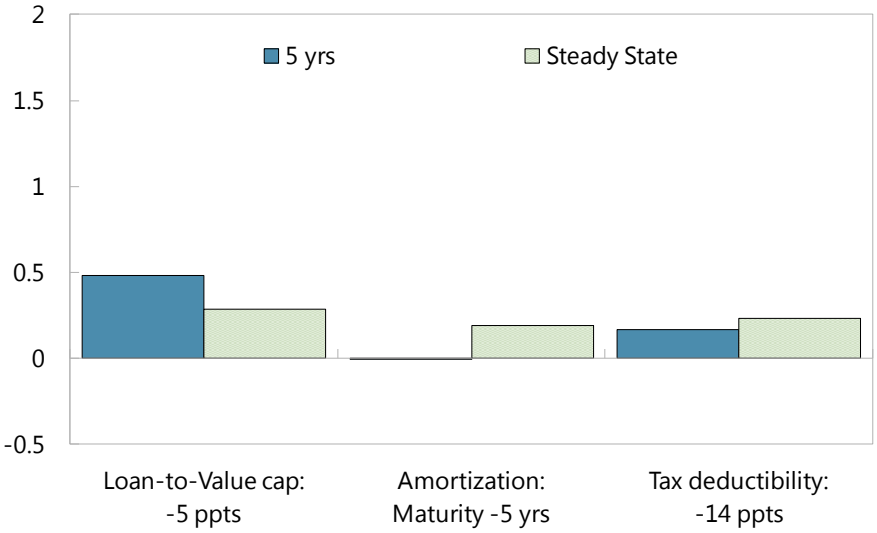


Sources: Fund staff calculations.

…without necessarily having sizable negative effects on households' consumption.

Change in Households' Consumption

(Percent)



Sources: Fund staff calculations.

(including any savings from interest tax deductibility) they will face with the eventual reduction in tax deductibility even before that reduction is fully phased in.

21. One concern about tightening macroprudential policy is that it will have a negative impact on households' consumption, but the results indicate any impact is small. As a measure of the impact on the economy of tightening macroprudential policies, we look at the effects on households' (goods) consumption. Similar to the analysis of the impact on the DTI ratio, we measure the impact on households' consumption after 5 years and in the new steady state. As the lower chart in Figure 2 illustrates, besides the amortization requirement after 5 years, for all of the instruments there is actually a small positive effect on consumption after tightening them.[9] Of course, this result is dependent on the various assumptions of the model and should be considered with caution. However, it does indicate that tightening macroprudential policies will not necessarily have significant negative effects on economy in the medium-term, especially if the tightening is gradual.

E. Policy Implications and Conclusions

22. Systemic risks from overvalued house prices and high household debt levels suggest that macroprudential policy measures should be tightened further. Both the empirical results in this paper and international experience suggest that tightening LTV limits and risk weights can slow mortgage credit and house price growth. Steps thus far to do so have been welcome, but there may be scope for gradually tightening these instruments further, including amortization requirements. At minimum, given divergent house price developments across regions, it may be useful to tighten these instruments for mortgages in certain regions (e.g., the Oslo area). Adding other macroprudential instruments would complement the current set of tools. In particular, LTV limits tend to be procyclical and this could be addressed by adding a debt-to-income (DTI) cap or a debt service-to-income (DSTI) limit to supplement the current affordability test.

Addressing structural factors contributing to high household debt and house prices would reinforce the impact of macroprudential policy measures. As illustrated above, gradually reducing the tax deductibility of mortgage interest can lower households' indebtedness. Moreover, increasing the supply of housing by relaxing restrictions on development can slow the pace of house price growth. Even regardless of the financial cycle and risks, these structural factors should be addressed to help reduce distortions in financial and real investment decisions.

[9] Though the shorter run dynamics differ slightly for each instrument, the main factors behind this positive impact on (goods) consumption are that the tighter macroprudential policy limits (i) increase the relative cost of borrowing to consume housing versus the cost of consuming goods, (ii) lower debt levels lead to lower debt service costs in the steady state, allowing for higher consumption. In the new steady state for reduced tax deductibility, borrowers in the model consume less housing, but more goods, while savers also consume slightly more as the revenue to the government from reducing mortgage interest tax deductibility is redistributed as transfers.

Appendix I. Details of Macroprudential Policies in Nordic Countries

Details of Macroprudential Policies in Nordic Countries

	Mandatory	Optional	Denmark	Finland	Sweden	Norway
CRD Instruments						
Countercyclical capital buffers	Y		Available on phased in basis from 0.5% in 2015 to 2.5% in 2019	Not activated	1% from September 2015	1% (reviewed every quarter; 1.5% from June 30, 2016)
D-SII Buffer	Y		1-3%, phased in over 2015-19	1% for largest 3 banks	2% (Pillar II, additional SRB for 4 major banks)	1% for 3 D-SIBs (2% from July 2016)
Systemic Risk Buffer		Y	No	No	3% for 4 major banks	3% for all banks
Liquidity Requirements under Pillar II		Y	Phasing in	Phasing in by 2017	All currency LCR of 100%	All currency LCR of 100% (from 2016 for 3 D-SIBs and gradually phased in for others by end-2017)
Other Pillar II		Y	2.5% conservation buffer	2.5% conservation buffer	2.5% conservation buffer	2.5% conservation buffer
CRR Instruments						
Additional Capital Buffers		Y	No	No	No	No
Risk Weights		Y	No	No	25% minimium RW floor for mortgages	The FSA estimates that, measures on LGD and PDs combined could increase average risk weighted assets on residential mortgages from 10-15% to 20-25%.
Probability of Default (PD) and Loss Given Default (LGD)		Y	No	No	No	Minimum EAD-weighted avg. LGD in IRB calculations for retail exposures secured by residential real estate in Norway increased from 10% to 20% The FSA consulted in February 2014 on a minimum requirement on average PDs for IRB calculations on residential mortgages (under which banks would have to assume a minimum number of crisis years, and that in these years the PD averages 3.5 percent); and on a tightening of risk classification and the estimation of LGD (based on an FSA reference model linking LGDs to LTVs).
Additional Liquidity Requirements			No	No	LCR of 100 in euro and USD	No
Large Exposures			No	No	No	No
Other						
LTV		Y	80% on first mortgages from mortgage banks	90% from July 2016 and 95% for first time buyers	LTV of 85%	LTV of 85% (guideline from December 2011 and regulation from July 2015)
LTI, DSTI, LTD limits and leverage ratio		Y	No	No	No	No, but 5 percent interest rate increase in affordability tests
Mortgage amortization			Some limits on share of interest only loans 1/	Amortization in most mortgage contracts	Proposal for 2% amortization per year until LTV=50%	Required 2.5% amortization per year for loans granted with LTV>70%
Reduce tax deductiblity of mortgage interest				Phasing out by 2019		
Others			Supervisory Diamond 1/			Upper LTV limit from 75% to 70% on interest only mortgages and home equity loans. Requirement that banks undertake an affordability check when borrowers take out a mortgage. The December 2011 guidelines increased the stress test to be used here to a 5 percentage point increase in mortgage interest rates

Sources: National authorities, IMF NRR (2013), Sweden Article IV, Denmark FSSA 2014, Jin, Lenain and Brien (2014) and Norges Bank Financial Stability Reports 2014 and 2015.

1/ Loan growth: Growth in lending to the individual customer segments must be below 15% per year. The four customer segments are private homeowners, residential rental properties, farms and other commercial

The borrower's interest rate risk: The proportion of loans where the loan-to-value (LTV) exceeds 75 per cent. the lending limit, and where interest rates are only locked for up to 2 years, must be less than 25 per cent. Applies only loans to individuals and loans for rental housing. There may be waived loans with cover in the form of interest rate swaps and the like.

Repayment Freedom of loans to private: The share of interest-only loans in LTV band above 75 per cent. the lending limit must not exceed 10 per cent. of the total loan volume. Grace loans count regardless of location in priority order.

Loans with short funding: The share of loans refinanced will by. quarter be less than 12.5 per cent. of the total loan portfolio and a year less than 25 per cent. of the loan portfolio.

Large exposures: The sum of the 20 largest exposures should be less than the Institute's actual core capital.

It is further clarified that banks are not covered by the supervisory diamond to mortgage banks. However, there will be launched reports for the banks' home loans so that FSA can monitor progress and intervene if the risky loans that supervisory diamond shall limit, move a large proportion of the banks.

Appendix II. Data Description for Empirical Analysis

Variable Definitions and Sources

Variable	Definition	Frequency	Source
Mortgage credit growth	Year on year percent change, repayment loans secured on dwellings from banks and mortgage companies	Monthly	Statistics Norway
Mortgage lending rate	Interest rate on new loans secured on dwellings, in percent	Monthly	Statistics Norway
Registered unemployment	NSA, in percent	Monthly	Statistics Norway
House price growth	Year on year percent change, (NSA, Thousand NOK per sq. meter)	Monthly	Real Estate Norway (NEF)
VIX	Index, in logarithm, CBOE Market Volatility Index	Monthly	Wall Street Journal
Consumer confidence in house purchase	Index, in logarithm	Quarterly	TNS Gallup
Spot crude oil price growth	Year on year percent change, UK Brent	Monthly	Wall Street Journal
Construction output growth	Year on year percent change (NSA, 2010=100)	Quarterly	Statistics Norway
Banks' funding cost growth	Year on year percent change, Risk Premium of Norwegian covered bonds over German bonds	Daily	Thomson Reuters Datastream, Bloomberg, DNB Markets, and Norges Bank
Mortgage risk weight	Average (EAD) risk weights for mass market IRB banks, based on banks consolidated reporting	Quarterly	Finanstilsynet
Banks' net tightening of LTV limts	Net balances scaled between -100 and +100 (weighted average based on banks' shares of lending to household; negative net percentage balances denote tighter credit standards)	Quarterly	Norges Bank Bank Lending Survey
Transfers of dwellings growth	Year on year percent change	Quarterly	Statistics Norway
Turnover time of housing market	In days	Monthly	Norges Bank, NEF
Population growth	Year on year percent change	Quarterly	Statistics Norway
Average yearly earnings growth	Year on year percent change	Quarterly	Norges Bank

Appendix III. Key DSGE Model Policy Parameters and Ratios

Key DSGE Model Policy Parameters and Ratios	
Key Policy Parameters	
Loan-to-Value (LTV) limit	90
Tax rate for mortgage interest deductibility	28
Maximum maturity on new mortgages (years)	50
Key Steady State Ratios	
Private Consumption/GDP	59
Private Investment/GDP	16
Household Debt/GDP	97
Household Debt/Disposable Income	181
Average LTV of Mortgage Stock	72

Sources: Chen and Columba (2016); Fund staff calculations.
Note: GDP used in the table is mainland GDP. Parameterization of the model aimed for steady state ratios similar to ratios in the data averaged over 10 years (in most cases). Policy parameters were set to resemeble those of actual policies for the LTV and tax rate parameters, while the maximum maturity on new mortgages (which implies a minimum amortization rate) was set to help achieve the targeted steady state household debt-to-disposable income ratio. The full set of parameters used to calibrate the Chen and Columba (2016) DSGE model to Norway are available upon request.

References

Ahuja, Ashvin and Malhar Nabar, 2011, "Safeguarding Banks and Containing Property Booms: Cross-Country Evidence on Macroprudential Policies and Lessons from Hong Kong SAR," IMF Working Paper, WP/11/284 (Washington: International Monetary Fund).

Arregui, N., J. Benes, I. Krznar, S. Mitra, and A. Oliveira Santos, 2013, "Evaluating the Net Benefits of Macroprudential Policy: A Cookbook," IMF Working Paper, WP/13/167 (Washington: International Monetary Fund).

Cerutti, Eugenio, Stijn Claessens, and Luc Laeven, 2015, "The Use of Effectiveness of Macroprudential Policies: New Evidence," IMF Working Paper, WP/15/61 (Washington: International Monetary Fund).

Chen, Jiaqian, and Francesco Columba, 2016, "Macroprudential and Monetary Policy Interactions in a DSGE Model for Sweden," IMF Working Paper, 16/74 (Washington: International Monetary Fund).

Crowe, Christopher, Giovanni Dell'Ariccia, Deniz Igan, and Pau Rabanal, 2013, "How to Deal with Real Estate Booms: Lessons from Country Experiences," Journal of Financial Stability, No. 9, pp. 300–319.

Bank of England, 2014, "The Financial Policy Committee's Power to Supplement Capital Requirements," Policy Statement (January) (London: Bank of England).

Igan, Deniz and Heedon Kang, 2011, "Do Loan-to-Value and Debt-to-Income Limits Work? Evidence from Korea," IMF Working Paper, WP/11/297 (Washington: International Monetary Fund).

International Monetary Fund (IMF), 2013a, Norway 2013 Selected Issues, IMF Country Report No. 13/273, 2013.

———, 2013b, "Key Aspects of Macroprudential Policy—Background Paper," IMF Policy Paper (Washington: International Monetary Fund).

Krznar, Ivo and James Morsink, 2014, "With Great Power Comes Great Responsibility: Macroprudential Tools at Work in Canada," IMF Working Paper, WP/14/83 (Washington: International Monetary Fund).

Kuttner, Kenneth N. and Ilhyock Shim, 2013, "Can Non-interest Rate Policies Stabilise Housing Markets? Evidence from a Panel of 57 Economies," BIS Working Papers, No. 433 (Basel: Bank for International Settlements).

Lim, Cheng Hoon, Francesco Columba, Alejo Costa, Piyabha Kongsamut, Akira Otani, Mustafa Saiyid, Torsten Wezel, Xiaoyong Wu, 2011, "Macroprudential Policy: What Instruments and How Are They Used? Lessons from Country Experiences," IMF Working Paper, WP/11/238 (Washington: International Monetary Fund).

Norges Bank, 2013, "Financial Stability Report," Norges Bank.

Reserve Bank of New Zealand, 2014, "C30 New Residential Mortgage Lending: Loan-to-Valuation Ratio (LVR)," Statistics (Wellington: Reserve Bank of New Zealand).

Wong, Eric, Tom Fong, Ka-fai Li and Henry Choi, 2011, "Loan-to-Value Ratio as a Macroprudential Tools—Hong-Kong's Experience and Cross-Country Evidence," HKMA Working Paper, No. 01/2011 (Hong Kong: Hong Kong Monetary Authority).