

Chapter 2 - The real exchange rate and phasing in of oil revenues

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1. Introduction

Two important changes in the guidelines for economic policy were implemented in spring 2001. A fiscal rule for the phasing in of oil revenues was introduced and an inflation target was adopted for monetary policy. Following these policy changes, we have experienced considerable fluctuations in the nominal krone exchange rate, which, combined with domestic cost inflation, has resulted in a deterioration in cost competitiveness. This article looks at the connection between the phasing in of oil revenues and movements in the real exchange rate.

The real exchange rate represents the price of Norwegian goods in relation to foreign goods, calculated in a common currency. Movements in the real exchange rate may therefore be due to price changes in Norway, price changes abroad, or changes in the nominal exchange rate itself. Within the framework studied in this article, the real exchange rate is defined as the price of non-tradeable goods in relation to tradeable goods, calculated in a common currency. A real appreciation means that non-tradeable goods have become more expensive in relation to tradeable goods – either because the nominal exchange rate has appreciated or because domestic price inflation (non-traded sector) is higher than abroad (traded sector).

The article is set out as follows: Section 2 illustrates how the phasing in of oil revenues affects industry structure and the real exchange rate from a theoretical point of view. The framework is standard and shows the widespread belief that the phasing in of oil revenues will result in a real appreciation of the Norwegian krone. The framework does provide an insight into how the phasing in affects the economy, but also has an obvious weakness – it is not able to give any

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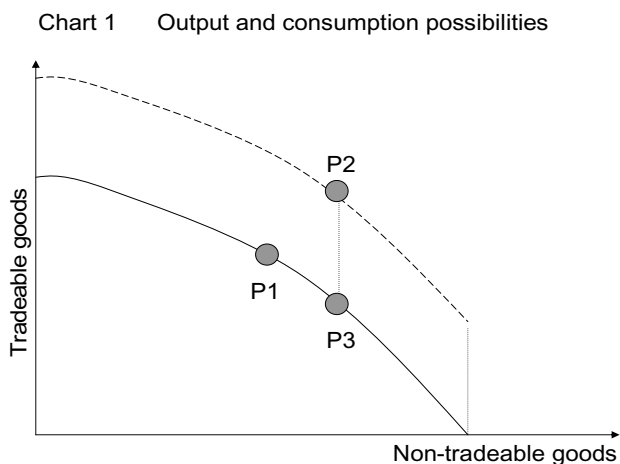
indication of what real exchange rate *path* will be. Section 3 is a review of the extensive body of literature that focuses on possible paths for the real exchange rate as a result of the phasing in of oil revenues. Four different paths are presented and the underlying assumptions for each of these paths are discussed. In section 4, the analysis is extended to take account of a gradual increase in the use of oil revenues. Section 5 looks at the apparent conflict between the real exchange rate paths presented in economic literature and the real exchange rate paths discussed in documents such as the National Budget for 2003 and Statistic Norway's Economic Survey 1/2003.

2. Oil revenues and the real exchange rate

2.1 Production and consumption

The belief that the phasing in of oil revenues will result in a real appreciation of the Norwegian krone is widespread. The reasoning for such a view is presented in Chart 1. The horizontal axis shows the production and consumption of non-tradeable goods, whereas the vertical axis shows the production and consumption of traditional tradeable goods - oil revenues are excluded for the moment. If we use a considerable share of the available labour and capital to produce non-tradeable goods, then less is available for the production of tradeable goods. This relationship is shown in Chart 1 by the production possibility frontier - the falling continuous line. The slope of the production possibility frontier shows the reduction in the production of tradeable goods when more non-tradeable goods are produced. At a given point in time, the production possibility frontier will become steeper the further to the right we are - if we already produce a lot of non-tradeable goods and only a few tradeable goods, we have to forego a considerable amount of tradeable goods in order to achieve one extra unit of non-tradeable goods. The reason for this is that labour and capital will to a certain extent be sector specific in the short run. For example, let us assume that only labour is mobile in the short run. If we already use a lot of labour in the non-traded sector, a further increase in the use of labour in this sector will only give a limited increase in production. There are already lots of workers to staff capital in the sector. On the other hand, a further reduction in the use of labour in the traded sector will result in a sharp fall in production - there are only a few workers to staff capital in the first place, and a further decrease will therefore reduce output considerably. Both effects pull in the direction of a steeper production possibility frontier.

Consumption can be adjusted at whichever point on the production possibility frontier society prefers, but without using oil revenues consumption cannot be sustained at a point that is not on the production possibility frontier – we have to limit our consumption to our income, and we get our income from production. People prefer a combination of non-tradeable and tradeable goods - let us imagine that consumption is adjusted at point P1 on the production possibility frontier.



2.2 The real exchange rate

At market equilibrium, the real exchange rate corresponds to the slope of the production possibility frontier. This can be explained by a simple numerical example. Let us assume that we are at a point where the slope of the production possibility frontier equals one. We then have to forego one unit of tradeable goods in order to achieve one extra unit of non-tradeable goods. If the price of non-tradeable goods is higher than the price of tradeable goods, the manufacturers will benefit from transferring resources from the production of tradeable to non-tradeable goods – they will get a higher price for non-tradeable goods than for tradeable goods, while production costs remain the same. If the price of non-tradeable goods is lower than that of tradeable goods, the opposite will happen – manufacturers will benefit from moving resources out of non-tradeable production and into tradeable production. Only when the price ratio between non-tradeable and tradeable goods is equal to the slope of the production possibility

frontier will there be nothing to gain from moving resources from one sector to the other. At market equilibrium, therefore, the price of non-tradeable goods relative to tradeable goods – or the real exchange rate – must be equal to the slope of the production possibility frontier.

At the same time, the real exchange rate must equal consumers' relative valuation of non-tradeable goods in relation to tradeable goods - if not, consumers will want a consumption that is out of step with what is being produced.

2.3 Oil revenues

Oil revenues represent a foreign exchange gift – the oil we sell gives us foreign currency income that can be used for imports. This foreign exchange gift also means that we can maintain a higher consumption of traditional tradeable goods than we ourselves produce. In Chart 1, consumption possibilities change as they move up the dotted curve and no longer coincide with production possibilities. The vertical distance between consumption possibilities and production possibilities indicates the volume of foreign currency income measured in units of tradeable goods.

Increased consumption possibilities mean that consumers want to consume more of both tradeable and non-tradeable goods. The new consumption point will therefore lie to the north-east of the old one, marked P2 in the chart. In order for consumers to be able to consume at P2, production has to be adjusted at P3. P3 lies vertically below P2 – we must continue to produce what we consume of non-tradeable goods. But in order to consume as many tradeable goods as we do at P2, we only need to produce as much as at P3 - the rest of the consumption of tradeable goods is covered by using oil revenues.

Thus we see that using oil revenues turns output in the direction of lower production of tradeable goods - P3 is lower than P1 in the chart, and higher production of non-tradeable goods - P3 lies to the right of P1. To put it simply: if we want to divide the increase in consumer spending equally between non-tradeable and tradeable goods, an increase of 1 krone in the use of oil revenues would reduce production in the traded sector by 50 øre and increase production in the non-traded sector by 50 øre. In this way, we can increase the consumption of both non-tradeable and tradeable goods by 50 øre.

At P3, the production possibility frontier is steeper than at P2 – non-tradeable goods have become more expensive relative to tradeable goods. The real exchange rate has appreciated. This real appreciation is necessary in order to adjust the economy to higher production of non-tradeable goods. For this to be profitable, the price of non-tradeable goods in relation to tradeable goods must rise - only then will manufacturers get the necessary signal to use more factor inputs in the production of non-tradeable goods and less in the production of tradeable goods.

The model outlined here is probably the basis of many economists' gut feelings about the effect of phasing in oil revenues, on the real exchange rate. In order to achieve equilibrium with the phasing in of oil revenues, the real exchange rate must appreciate. This jump in the real exchange rate is necessary in order to achieve equilibrium in the real economy when the use of oil revenues increases.²

However, what is not shown in Chart 1 is just as important as what is shown: the chart says nothing about the possible *time paths* in the real exchange rate. The reason for this is that the underlying model is static. The model only says that if we, at a given point in time, increase our use of oil revenues, a real appreciation will be necessary in order to maintain market balance - increased demand necessitates increased production of non-tradeable goods, which in turn requires a real appreciation. The next section gives an overview of economic literature that looks at how the real exchange rate is affected by the phasing in of oil revenues within dynamic models.

3. The real exchange rate over time

The production possibility frontier will change over time – and the change may depend on the phasing in of oil revenues. The analysis in the above section therefore only indicates what can be expected to happen to the real exchange rate in order to achieve market balance in the short

² Note that what the model does identify is a jump in the *real exchange rate*. It does not say whether this change occurs via domestic prices or the nominal exchange rate. This would probably depend on the prevailing monetary policy regime. If it is a credible fixed exchange rate regime, demand pressures when the oil revenues are phased in could translate into a rapid rise in the price of non-tradeable goods, whereas if it is a regime with a floating exchange rate the jump in the nominal exchange rate could contribute to the change in the real exchange rate.

run, but does not say much about movements in the real exchange rate over time. In order to analyse this, it is necessary to abandon the static framework and move on to dynamic analyses – analyses that explicitly model how the phasing in of oil revenues will affect the economy over time.

Dynamic models that illustrate the phasing in of oil revenues can be divided into two main groups: models that take the speed of the phasing in of oil revenues as given and models that discuss how fast oil revenues are phased in to the economy. In this article, discussion will be restricted to the first main group - in other words, we will look at movements in the real exchange rate given that a fiscal rule for phasing in oil revenues has been introduced. The models in the second main group will not be discussed – those who are interested can refer to Mansoorian (1991) for a descriptive model of overutilisation of resource wealth, to Robinson, Verdier & Torvik (2002) for political economic theory regarding the phasing in and allocation of oil revenues, and to Matsen & Torvik (2003) for a normative model that derives the optimal phasing in of oil revenues. In the remainder of this article, it is therefore assumed that the speed with which oil revenues will be phased in has already been politically determined and we will discuss the consequences of this for the real exchange rate.

3.1 Real exchange rate paths – an overview

Movements in the real exchange rate in the dynamic models are determined by three key features that differentiate them from the static model used above³:

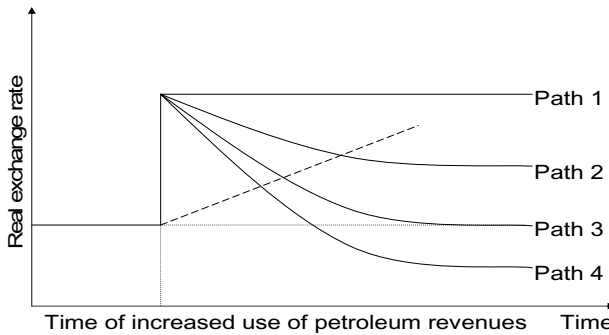
- Factor inputs are more mobile in the long run than in the short run.
- As it is possible to change factor inputs that are given in the short term, for example, capital volume, the returns to scale of product functions will differ in the short and long term.
- Output growth in the different sectors is affected by the phasing in of oil revenues.

³ The discussion on movements in the real exchange rate in the dynamic models that follows will contain mechanisms taken from several different sources in economic literature. The overview given here is based on, first and foremost, Corden & Neary (1982), Corden (1984), Neary & Purvis (1983), Neary & van Wijnbergen (1986), Steigum (1992), Torvik (2001) and van Wijnbergen (1984a). For an overview of which mechanisms are applied in which article and other mechanisms that affect real exchange rate movements discussed in economic literature, see Torvik (2001).

In literature that expands on the static model used in the previous section in order to discuss what movements in the real exchange rate will be over time, four different exchange rate paths are put forward.

The path you get depends on the features of the economy summarised in the three points above.⁴ The real exchange rate paths discussed in economic literature are shown in Chart 2.

Chart 2 Real exchange rate paths in connection with the phasing in of petroleum revenues



Path 1 show a scenario where all factor inputs are equally mobile in the short term and long term, and where production has decreasing returns to scale. The initial appreciation from the static model then takes us immediately to the dynamic equilibrium – there is no difference between the short and long term.

Path 2 shows a scenario where factor inputs are more mobile in the long run than the short run

⁴ Strictly speaking, it could be said that a fourth feature of the economy - the private sector's demand response to increased public use of oil revenues - is also of importance to the real exchange rate paths. This is a key factor in models that study Ricardian equivalence. It is possible that the private sector may counteract the increased use of oil revenues by reducing their demand. If the reduced private sector demand perfectly counteracts the phasing in of oil revenues, the result may be that the real exchange rate does not need to appreciate when the use of oil revenues is increased. An underlying premise in the analysis in this article is therefore that the increased use of oil revenues, either in the form of higher public spending or tax cuts, will entail a net increase in demand. Other aspects of the private sector's demand response may also be of significance – see Footnote 5.

and where production also has decreasing returns to scale in the long run. Following an initial appreciation, factor inputs are gradually moved from the traded to the non-traded sector. The supply of non-tradeable goods therefore increases relative to the supply of tradeable goods - and when this happens, the price of non-tradeable goods in relation to tradeable goods starts to fall. The price will continue to fall until the reallocation of factor inputs has ended. In the new long-run equilibrium, there has been a real appreciation compared with the situation prior to the phasing in of oil revenues. Even in the long term, it is necessary to have higher prices for non-tradeable goods relative to tradeable goods, because production has decreasing returns - and the relative price then has to be changed in order to change the relative production.

In relation to the initial change in the exchange rate, we now have a depreciation – the short-run exchange rate appreciation represents what is often termed overshooting. But overshooting in this context is something different from what is meant by overshooting in literature about monetary policy, where an overshooting of the *nominal* exchange rate is the result of changes in expectations regarding future interest rate differentials. The overshooting of *the real exchange rate* that arises in dynamic models with the phasing in of oil revenues, has other causes – it is a short-term price signal in the real economy that is necessary in order to achieve market equilibrium. (Naturally, this does not preclude the fact that nominal overshooting could be the mechanism that gives the necessary overshooting in the real exchange rate – in an economy with a floating exchange rate, the most important changes will, in most cases, originate from changes in the nominal exchange rate).

Path 3 shows a scenario where factor inputs are more mobile in the long run than the short run, but where production has constant returns to scale in the long run. The initial real appreciation will continue to be followed by a depreciation when the supply of non-tradeable goods increases relative to the supply of tradeable goods. But factor inputs will now only be reallocated as long as the real exchange rate is higher than it was initially – with constant returns in production, manufacturers only need a higher price for the period when they are transferring factor inputs between the sectors. When this has been done, the price falls back to its original level. With constant returns in production in the long run, there is no need to change the relative price in order to change the relative production.

Path 4 shows a scenario from more recent endogenous growth theory, where the phasing in of

oil revenues affects productivity growth. These theories discuss different effects that may pull in the direction of both higher and lower productivity growth as a result of phasing in oil revenues. The discussion naturally focuses on how oil revenues affect the *absolute* level of a country's productivity – see Røisland & Torvik (2000) and Torvik (2001) for a more extensive discussion of this literature. However, in terms of the effect on the real exchange rate, it is the *relative* level of productivity between the non-traded and traded sectors that is decisive - and here the different contributions from more recent endogenous growth theory concur: in the long run, the non-traded sector becomes comparatively more productive than the traded sector as a result of the phasing in of oil revenues.

When oil revenues are phased in, production in the traded sector falls and production in the non-traded sector rises. A decline in production in the traded sector pulls in the direction of lower productivity growth in this sector, not only because the knowledge that is acquired through manufacturing decreases, but also because the incentives for research and development decrease. The effect in the non-traded sector is the opposite. Higher production generates more knowledge and increases incentives for research and development. Given that the spill-over effect on skills between the sectors does not dominate the direct effect within each sector, the non-traded sector will be relatively more productive than the traded sector.

In turn, the shift in relative productivity has implications for the real exchange rate. When productivity in the non-traded sector rises at a faster pace than productivity in the traded sector, the supply of non-tradeable goods expands more rapidly than the supply of tradeable goods. A larger supply of non-tradeable goods relative to tradeable goods will lead to a fall in prices for non-tradeable goods in relation to tradeable goods - i.e. there is a real depreciation. The result is a version of the wellknown Balassa-Samuelson effect: when relative productivity between the traded and non-traded sectors moves in one direction, the relative price will move in the other direction. The only difference is that in the model used here, changes in relative productivity are not given exogenously, but are determined within the model - and dependent on the phasing in of oil revenues.

In path 4, the long-run real exchange rate will lie at a lower level than prior to the phasing in of oil revenues. The short-run appreciation is not only an overshooting of the long-run equilibrium level – it is also a movement in the opposite direction.

We see that the assumption regarding returns to scale in the production function is decisive to movements in the real exchange rate as a result of an increase in oil revenues. Models with decreasing returns entail an appreciation in the real exchange rate, models with constant returns entail no change in the real exchange rate, whereas models with (dynamic) increasing returns to scale entail a long-term depreciation of the real exchange rate⁵. A shared feature of the paths for real exchange rate movements discussed here is that initially there is a relatively swift appreciation of the real exchange rate, which is then followed by a depreciation.

4. Gradual phasing in of oil revenues

In the previous section, we considered a permanent one-off increase in the use of oil revenues. We will now look at the effect if oil revenues are phased in gradually. Before we reach long-run equilibrium where we use a constant share of petroleum wealth, the phasing in entails rising use of oil revenues.

In this case, agents' expectations of the future and the way in which these manifest will be decisive. It is useful to differentiate between two extremes. In the one scenario, agents are not forward-looking and in the other, they perfectly predict all current and future effects of the phasing in and take optimal consideration of these when making decisions. Most people will be of the view that agents' actual expectations and behaviour lie somewhere between the two extremes.

⁵ Mechanisms other than those discussed above can influence the real exchange rate path even though they do not affect the long-run result. For example, we have not discussed temporary unemployment in the transition period between equilibria. For an analysis of a model with unemployment, see van Wijnbergen (1984b). Nor have we placed much importance on discussing *intra*temporal or *inter*temporal substitution on the part of the consumer. The closer substitutes for non-tradeable and tradeable goods are at any given time, the smaller the initial real appreciation will be. The rise in prices for non-tradeable in relation to tradeable goods will then switch much of demand from non-tradeable goods to tradeable goods. Intertemporal substitution will give the following effect: the more easily consumers can substitute their consumption over time, the smaller the initial real appreciation will be, but the slower the real exchange rate will be in returning to its original level. The reason for this is that consumers will switch consumption of non-tradeable goods from periods when they are temporarily "expensive" (in the first stages of the phasing in) to periods when they are "cheaper" (in the later stages of the phasing in). The increase in demand will therefore be less earlier on, and more later on, than if consumers had difficulties in moving consumption over time. Nor have we touched on expectations formation and investment, which will be mentioned in section 4 .

Let us first assume that agents are not forward-looking – the increase in the use of oil revenues comes as a surprise in each period and the shock is repeated over time. Initially, the same mechanism will apply as in the section above. The increase in demand for non-tradeable goods necessitates a higher price for these relative to the price for tradeable goods - the real exchange rate appreciates. Following this initial real appreciation, there are two mechanisms that will pull the real exchange rate in different directions over time.

On the supply side of the economy, factors of production are reallocated to the non-traded sector - the relative supply of non-tradeable goods increases and this pulls in the direction of a real depreciation in the exchange rate, as is the case with a one-off increase in the use of oil revenues. On the demand side, there is a rise in demand for non-tradeable goods while oil revenues are being phased into the economy. In other words, the supply of and demand for non-tradeable goods in the market will both rise over time – whether the initial appreciation is then followed by a period of real appreciation or real depreciation depends on which effect is the strongest. If the effect through increased supply is strongest, there will be a real depreciation. If the opposite is the case, the initial appreciation will be followed by a further appreciation. When the phasing in period is complete, we return to the analysis in the previous section and the long-run effects on the real exchange rate are determined by the factors discussed there.

At the other extreme - where agents' perfectly predict the future – the real exchange rate will return to its original level more swiftly. Also there will now be a jump in the real exchange rate at the start of the phasing in – this jump is necessary in the short run in order to achieve market equilibrium when demand rises. But manufacturers will see that the demand for non-tradeable goods continues to rise and will therefore reallocate more factor inputs at an earlier stage than if they did not expect this. The more forward-looking manufacturers are, the faster the supply of non-tradeable goods will rise and the faster the real exchange rate will depreciate, following the initial appreciation.

With a gradual phasing in of oil revenues, there would be a period of rising demand for non-tradeable goods. The more forward-looking manufacturers are, the more supply will keep pace with demand and the faster the real exchange rate will depreciate after the initial appreciation. The level at which the real exchange rate finally settles is determined by the same factors mentioned in the scenario with a one-off permanent increase in the use of oil revenues.

5. Gradual real appreciation?

In summary, key results of literature on the phasing in of oil revenues are as follows: when oil revenues are phased in, there will initially be a period with a real appreciation followed by a period with a real depreciation. It is interesting to note that this is contrary to the path for the real exchange rate apparently underlying the decision to change policy guidelines in spring 2001. It is also contrary to the paths discussed by key participants in the ongoing national debate on the economy, for example, as presented in Statistics Norway's "Perspectives" in Economic Survey 1/2003.

The guidelines for economic policy are set out in Report to the Storting no. 29 of 29 March 2001, which introduces the fiscal rule and the inflation target for monetary policy. It appears that the reasoning behind the simultaneous introduction of the fiscal rule and inflation target is that they support each other and ensure that the nominal exchange rate remains relatively stable. The phasing in of oil revenues necessitates a real appreciation. An inflation target that is somewhat higher than that of our trading partners may contribute to this over time. Note that such reasoning says somewhat more than simply what movements in real exchange rate will be - it also indicates what the *nominal* path of variables included in the real exchange rate might be.

The National Budget for 2003 refers to calculations that show a necessary real appreciation in the region of 4-8 per cent in the period to 2010. This ties in well with an inflation target that aims to hold inflation at $\frac{1}{2}$ - 1 per cent above that of our trading partners. This will perhaps ensure that we achieve a real appreciation even though the nominal exchange rate is stable. In the National Budget, it is stated:

"The nominal appreciation of the krone has contributed to a clear deterioration in cost competitiveness. This deterioration is considerably greater than that which is estimated as a result of the phasing in of oil revenues in the period to 2010, in accordance with the fiscal rule for budget policy."

And in the discussion on monetary policy it is pointed out that the real exchange rate has appreciated by around 15 per cent since the start of 2001. It further states:

"Participants in the foreign exchange market will be able to anticipate a deterioration of competitiveness as a result of a gradual increase in the use of oil revenues. The nominal appreciation of the krone exchange rate in recent months has, however, contributed to a deterioration in cost competitiveness that is considerably greater than that which our calculations of an increase in the use of petroleum revenues in line with the fiscal rule for budget policy would entail."

It is easy to get the impression from the background documents on the changes in economic policy in spring 2001 and the discussions in the National Budget, that the real appreciation in the period to 2010 will occur gradually.

The idea of a gradual real appreciation is also referred to in Economic Survey 1/2003. In "Perspectives" it says:

"It is also assumed in the argument for changing the guidelines for economic policy in 2001 that an inflation rate peculiar to Norway that is around half a per cent higher than that of our trading partners, with a corresponding deterioration in competitiveness, will be necessary and sufficient to realise the structural changes required by the more expansionary fiscal stance that the fiscal rule entails. There should therefore be no need for a nominal appreciation of the krone."

It continues:

"A comparison of the reasoning for and intentions underlying the policy changes in 2001 and actual developments in 2001 and 2002 highlights a substantial discrepancy. A stronger krone resulted in a real appreciation that was considerably more than half a per cent each year."

A path with a gradual real appreciation is illustrated by the dotted line in Chart 2 - a real appreciation can occur with a stable nominal exchange rate. But is this scenario realistic? There are at least two key arguments against the view that the phasing in of oil revenues will result in gradual real appreciation and that this can happen with a stable nominal exchange rate. The first argument is that this exchange rate path conflicts with the real exchange rate paths outlined in theoretical literature on the phasing in of oil revenues. The theoretical literature may,

of course, have disregarded important mechanisms that pull in the opposite direction and that are strong enough to dominate the standard effects. It is also possible that conditions peculiar to Norway may entail that the phasing in of oil revenues has different effects here than in other countries. If this is so, it is important to identify these mechanisms and conditions more clearly than is the case in the documents referred to here.

Whereas the first argument is linked to the real exchange rate path, the second is linked to how realistic the notion of a stable nominal exchange rate is. A fixed nominal exchange rate means that monetary policy has to be oriented towards a nominal interest rate level that is the same as that of our trading partners. As we have a higher inflation target, this means that real interest rates in Norway will be lower than those of our trading partners. Monetary policy shall be expansive. The phasing in of oil revenues also entails an expansionary stance. We would then have an economic policy that comprises an expansionary fiscal policy and an expansionary monetary policy, at the same time that we have to achieve the inflation target. The reality of this is questionable.

6. Concluding comments

When oil revenues are phased into the economy, there is reason to first expect a period where the exchange rate appreciates rapidly, before then entering a phase with a gradual real depreciation. The appreciation in the initial stages of the phasing in is necessary in order to achieve equilibrium – the phasing in of oil revenues will result in higher demand for non-tradeable goods that has to be met through increased national production. This necessitates a rise in the price for non-tradeable goods relative to tradeable goods. In the long run, the reallocation of production resources to the non-traded sector and possibly also changes in relative productivity between the non-traded and traded sectors, will result in an increase in the supply of non-tradeable goods in relation to traditional tradeable goods. This will pull in the direction of a real depreciation of the exchange rate.

The real exchange rate paths underlying the introduction of the fiscal rule and inflation target seem to differ considerably from the paths discussed in economic literature. It is questionable whether a gradual real appreciation of the exchange rate in the event of oil revenues being

phased in, is realistic. The economic mechanisms that underlie such paths should be elucidated more and the reasons why there is this discrepancy with standard theoretical literature should be clarified.

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