Preliminary. Comments welcome.

Leaning Against the Wind: The Role of Different Assumptions About the Costs

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Abstract

"Leaning against the wind" (LAW), that is, tighter monetary policy for financial-stability purposes, has costs in terms of a weaker economy with higher unemployment and lower inflation and possible benefits from a lower probability or magnitude of a (financial) crisis. A first obvious cost is a weaker economy if no crisis occurs. A second cost—less obvious, but higher—is a weaker economy *if* a crisis occurs. Taking the second cost into account, Svensson (2017) shows that for representative empirical benchmark estimates and reasonable assumptions the costs of LAW exceed the benefits by a substantial margin. Previous literature has disregarded the second cost, by assuming that the *crisis loss level* is independent of LAW. Some recent literature has effectively disregarded the second cost, making it to be of second order by assuming that the *cost of a crisis* (the crisis loss level less the non-crisis loss level) is independent of LAW. In these cases where the second cost is disregarded, for representative estimates a small but economically insignificant amount of LAW is optimal.

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1 Introduction

"Leaning against the wind" (of asset prices and credit booms) (LAW for short) refers to a monetary policy that is somewhat tighter (that is, with a somewhat higher policy interest rate) than what is consistent with flexible inflation targeting without taking any effects on financial stability into account. LAW has obvious costs in terms of a weaker economy with higher unemployment and lower inflation. It has been justified by possible benefits in the form of a lower probability or smaller magnitude of future (financial) crisis (BIS (2014, 2016), Olsen (2015), Sveriges Riksbank (2013)), although, strikingly, without the support of a credible numerical cost-benefit analysis (Allen, Bean, and Gregorio (2016)). Svensson (2017) (first version distributed as Svensson (2016a)) provides a framework for such an analysis and benchmark numerical estimates of the costs and benefits of LAW. The result is that the costs exceed the benefits by a substantial margin. Extensive robustness tests indicate that this result is quite robust. For example, to overturn the result, the effects of LAW on the probability or magnitude of a crisis need to be more than 5–40 standard errors larger than typical empirical estimates in the literature.

The framework takes two costs of LAW into account, in addition to the possible benefits from a lower probability and smaller magnitude of a crisis. The first cost is the obvious cost of a weaker economy if no crisis occurs. But there is a second cost of LAW, less obvious but higher, which has been overlooked by the previous literature. If a crisis occurs when the economy is weaker because of LAW, for a given magnitude of a crisis the economy will be weaker also in the crisis. For a given magnitude of a crisis, the crisis loss level and the cost of a crisis will be higher with LAW than without.

The two costs can be understood with the help of a simple example in terms of unemployment gaps: First, suppose that *without* LAW the non-crisis unemployment gap is zero. Suppose that a crisis increases the unemployment gap by 5 percentage points (pp). Then the crisis unemployment gap is $0 + 5 = 5$ pp. With a quadratic loss function, the *non-crisis loss* is $0^2 = 0$, and the *crisis loss* is $5^2 = 25$. The *cost of a crisis*, defined as the crisis loss less the non-crisis loss, is $25 - 0 = 25$.

Next, suppose that *with* LAW the non-crisis unemployment gap is 0.5 pp instead of 0. Then the crisis unemployment gap will be $0.5 + 5 = 5.5$ pp instead of 5. Then the non-crisis loss will be $0.5^2 = 0.25$ instead of 0, and the crisis loss will be $5.5^2 = 30.25$ instead of 25. The first cost of LAW is the *non-crisis loss increase* due to LAW, $0.25 - 0 = 0.25$. The second is the *crisis loss increase* due to LAW, $30.25 - 25 = 5.25$. The second cost is the main cost of LAW. Furthermore, the cost of a crisis (the crisis loss less the non-crisis loss) is $30.25 - 0.25 = 30$ instead of 25. *The cost of a crisis is higher with LAW than without.* In this example, the first cost of LAW is of the second order, whereas the second cost is of the first order. It follows that, for a zero non-crisis unemployment gap, the marginal cost is zero for the first cost of LAW but positive for the second cost. Overlooking the second cost misses that *the marginal cost of LAW is positive, not zero.*

The previous literature trying to quantify the costs and benefits of LAW (including Ajello, Laubach, Lopez-Salido, and Nakata (2016), Diaz Kalan, Laséen, Vestin, and Zdzienicka (2015), Svensson (2014, 2015), and IMF (2015)) has used an alternative assumption about the loss function. It has assumed that *the crisis loss level is constant and independent of LAW*, thereby disregarding the second cost of LAW, the main cost of LAW. In terms of the example above: Suppose again that with LAW the non-crisis unemployment gap is 0.5 pp. In the framework above, the crisis unemployment gap, the crisis loss, and the crisis loss increase are, respectively, 5.5 pp, $5.5^2 = 30.25$, and $30.25 - 25 = 5.25$. In the previous literature, they are instead, respectively, 5 pp, $5^2 = 25$, and $25 - 25 = 0$, regardless of the non-crisis unemployment gap. The second cost of LAW, the crisis loss increase, is thus zero instead of positive. Then, with the first cost being of second order, it follows that, for a zero non-crisis unemployment gap, the marginal cost of LAW will be zero instead of positive. With a positive marginal benefit of LAW, *some* LAW will then be optimal. However, as we shall see, the optimal LAW is quite small, corresponding to a policy-rate increase of only a few basis points (bp), and thus of no practical relevance, as shown by Ajello et al. (2016).

The alternative assumption of a constant crisis loss has the counter-intuitive implication that the cost of a crisis (the crisis loss less the non-crisis loss) is *decreasing* in the non-crisis loss. In particular, if the non-crisis unemployment gap for some reason would be above 5 pp, the economy would be better off in a crisis, because then the unemployment gap would drop to 5 pp. It trivially follows that *the cost of a crisis is lower with LAW than without*, because LAW would increase the non-crisis loss without affecting the crisis loss.

More recently, Filardo and Rungcharoenkitkul (2016) and Gourio, Kashyap, and Sim (2017) (FR and GKS for short) have responded to Svensson (2016a), arguing that LAW would be optimal and maintaining that this contradicts my result. However, as suggested in the Svensson (2016b) of FR, their results may be explained by them using a second alternative assumption, namely that *the cost of a crisis is constant and independent of LAW.* In terms of the simple example above: FR and GKS can be interpreted as assuming that the unemployment gap is not affected by a crisis and that there is a separate constant cost of a crisis (the crisis loss less the non-crisis loss) that is always 25, regardless of the non-crisis unemployment gap. Then, without LAW, the non-crisis loss is zero and the crisis loss is 25. With LAW, the non-crisis loss is 0.25, and the crisis loss is $0.25 + 25 = 25.25$. The first cost of LAW, the non-crisis loss increase, is $0.25 - 0 = 0.25$. The second cost, the crisis loss increase, is $25.25 - 25 = 0.25$, equal to the first. Thus, the second cost is not zero, as when a constant crisis loss is assumed, but it is as small as the first cost and thus of second order.

Their assumption then has the same implications as the assumption of a constant crisis loss. For a zero non-crisis unemployment gap, the marginal cost of LAW is zero, whereas the marginal benefit is positive. Some LAW is then optimal. But again, as we shall see and as shown for a constant crisis loss in Ajello et al. (2016), the optimal LAW is quit small and hardly economically significant.

Outline Section 2 summarizes the theoretical framework and section 3 summarizes the benchmark numbers used and the main result of Svensson (2017). Section 4 examines the two alternative assumptions and their consequences. Section 5 concludes.

2 Theoretical framework

This section summarizes the theoretical framework used in Svensson (2017) (CB for short) to assess the costs and benefits of LAW. Let u_t denote the unemployment rate in quarter $t \geq 1$, and let u_t^* denote the optimal unemployment rate under flexible inflation targeting when the possibility of a financial crisis is disregarded. It is here called the *benchmark unemployment rate*. As explained in CB (appendix A), it depends on exogenous cost-push shocks to the underlying Phillips curve.

Let the *unemployment deviation*, $\tilde{u}_t$, be defined as the deviation of the unemployment rate from the benchmark unemployment rate, $\tilde{u}_t \equiv u_t - u_t^*$. Thus the unemployment deviation is *not* the deviation from the steady state (or the unemployment gap as in the simple example in section 1) but the deviation from the optimal policy under flexible inflation targeting when the probability of a crisis is set to zero. As explained in CB (appendix A), the loss from the unemployment rate deviating from the benchmark unemployment rate can be represented by the simple quadratic (indirect) loss function,

$$L_t = (\tilde{u}_t)^2, \tag{2.1}$$

where L_t denotes the quarter-t (simple) loss.[1] The quarter-1 intertemporal loss function for monetary policy is then

$$\mathcal{L}_1 = \mathrm{E}_1 \sum_{t=1}^{\infty} \delta^{t-1} L_t = \sum_{t=1}^{\infty} \delta^{t-1} \mathrm{E}_1 L_t, \tag{2.2}$$

where E_1 denotes expectations conditional on information available in quarter 1, $\delta \in (0,1)$ denotes a discount factor, and $\mathrm{E}_1 L_t$ denotes the expected quarter-t loss for $t \geq 1$.

2.1 The benchmark case

In the benchmark case, the expected quarter-t loss is given by

$$\mathrm{E}_1 L_t = \mathrm{E}_1(\tilde{u}_t)^2 = (1-p_t)\mathrm{E}_1(\tilde{u}_t^{\mathrm{n}})^2 + p_t\, \mathrm{E}_1(\tilde{u}_t^{\mathrm{c}})^2 \equiv (1-p_t)\mathrm{E}_1(\tilde{u}_t^{\mathrm{n}})^2 + p_t\, \mathrm{E}_1(\tilde{u}_t^{\mathrm{n}} + \Delta u_t)^2 \tag{2.3}$$

for $t \geq 1$. Here it is assumed that, in quarter $t \geq 2$, there can be either of two states of the world, namely either a *non-crisis* or a (financial) *crisis*, denoted n and c, respectively. By assumption, there is no crisis in quarter 1. Furthermore, p_t denotes the *probability of (having) a crisis* in quarter t, conditional on information available in quarter 1. The variable $\tilde{u}_t^{\mathrm{n}}$ denotes the quarter-t *non-crisis unemployment deviation*, that is, the unemployment deviation if there is no crisis in the quarter. Then the first term of the right side of (2.3) is the probability of no crisis, $1-p_t$, times the *expected non-crisis loss*, $\mathrm{E}_1 L_t^{\mathrm{n}} = \mathrm{E}_1(\tilde{u}_t^{\mathrm{n}})^2$, that is, the expected loss if there is no crisis in quarter t.

The second term on the right side of (2.3) is the probability of a crisis times the *expected crisis loss*, $\mathrm{E}_1 L_t^{\mathrm{c}} = \mathrm{E}_1(\tilde{u}_t^{\mathrm{c}})$, that is, the expected loss if there is a crisis in quarter t. A crisis is assumed to be associated with a (possibly random) *crisis increase in the unemployment rate*, $\Delta u_t > 0$. Then the *crisis unemployment deviation*, $\tilde{u}_t^{\mathrm{c}}$, satisfies

$$\tilde{u}_t^{\mathrm{c}} \equiv \tilde{u}_t^{\mathrm{n}} + \Delta u_t, \tag{2.4}$$

and the crisis loss is

$$L_t^{\mathrm{c}} = (\tilde{u}_t^{\mathrm{c}})^2 \equiv (\tilde{u}_t^{\mathrm{n}} + \Delta u_t)^2. \tag{2.5}$$

This crisis increase in the unemployment rate is net of any policy response during a crisis. Thus, Δu_t can be interpreted as the unemployment-rate increase that is equivalent to the combination of a demand shock and any shock to the transmission mechanism of monetary policy associated with a crisis, net of the conventional and unconventional policy response at a crisis, including any

[1] The "true" (indirect) loss function is an affine function of the simple (indirect) loss function.

restriction on the policy response such as the lower bound of the policy rate. It represents the *magnitude of a crisis*.[2]

Equation (2.3) can be written as [3]

$$\mathrm{E}_1 L_t = \mathrm{E}_1(\tilde{u}_t^{\mathrm{n}})^2 + p_t\,[\mathrm{E}_1(\tilde{u}_t^{\mathrm{n}} + \Delta u_t)^2 - \mathrm{E}_1(\tilde{u}_t^{\mathrm{n}})^2] = \mathrm{E}_1(\tilde{u}_t^{\mathrm{n}})^2 + p_t\,[\mathrm{E}_1(\Delta u_t)^2 + 2\mathrm{E}_1\tilde{u}_t^{\mathrm{n}}\,\mathrm{E}_1\Delta u_t]. \quad (2.6)$$

Here, the expression in square brackets in (2.6) is the (expected) *cost of a crisis*, that is, the (expected) crisis loss less the (expected) noncrisis loss, $\mathrm{E}_1(L_t^{\mathrm{c}} - L_t^{\mathrm{n}})$. We see in the square brackets on the right side of (2.6) that the (expected) cost of a crisis is *increasing* in the (expected) non-crisis unemployment deviation, $\mathrm{E}_1\tilde{u}_t^{\mathrm{n}}$. (When no confusion need arise, for brevity "expected" will often be left out but be understood in the rest of the paper.)

Thus, a *zero* non-crisis unemployment deviation corresponds to the optimal policy under flexible inflation targeting when the probability of a crisis is set to zero. This can be seen as a policy of *no leaning* (NL for short). A *positive* non-crisis unemployment deviation corresponds to *tighter* policy than NL and can thus be seen as representing LAW. A *negative* non-crisis unemployment deviation corresponds to *easier* policy than NL and can be seen as representing leaning *with* the wind (LWW for short).

Consider the effect on the intertemporal loss (2.2) of a policy tightening in the form of an increase in the policy rate during quarters 1–4, denoted $d\bar{i}_1 > 0$. The cumulative net marginal cost of LAW, NMC, is defined as the derivative of the intertemporal loss with respect to the policy rate during quarters 1–4, $\mathrm{NMC} \equiv d\mathcal{L}_1/d\bar{i}_1 = (d/d\bar{i}_1)\,\mathrm{E}_1\sum_{t=1}^{\infty}\delta^{t-1}L_t = \sum_{t=1}^{\infty}\delta^{t-1}d\mathrm{E}_1L_t/d\bar{i}_1$.

Furthermore, define the quarter-t net marginal cost, NMC_t, as $d\mathrm{E}_1L_t/d\bar{i}_1$, the policy-rate effect on the quarter-t expected loss. Taking the derivative of the right side of (2.6) with respect to $\bar{i}_1$

[2] The benchmark assumption is for simplicity that the benchmark unemployment rate, u_t^*, is independent of whether there is a crisis or not, in which case Δu_t is the crisis increase in the unemployment rate. As explained in CB (appendix B), if the benchmark unemployment rate is correlated with a crisis, the crisis increase in the unemployment rate and in the unemployment deviation are not the same. Then Δu_t is the crisis increase in the unemployment *deviation* and equals the crisis increase in the unemployment rate less the crisis increase in the benchmark unemployment rate. Because the benchmark unemployment rate is increasing in cost-push shocks to the Phillips curve and such cost-push shocks are likely to be negative in a crisis, any crisis increase in the benchmark unemployment rate is likely to be negative.

[3] It is assumed that $\mathrm{E}_1(\tilde{u}_t^{\mathrm{n}}\Delta u_t) = \mathrm{E}_1\tilde{u}_t^{\mathrm{n}}\,\mathrm{E}_1\Delta u_t$, that is, $\tilde{u}_t^{\mathrm{n}}$ and Δu_t are uncorrelated conditional on information available in quarter 1.

gives $\mathrm{NMC}_t \equiv \mathrm{MC}_t - \mathrm{MB}_t$, where

$$\mathrm{MC}_t \equiv 2\,(\mathrm{E}_1\tilde{u}_t^{\mathrm{n}} + p_t \mathrm{E}_1 \Delta u_t)\frac{d\mathrm{E}_1 u_t^{\mathrm{n}}}{d\bar{i}_1} = 2\,\mathrm{E}_1\tilde{u}_t \left.\frac{d\mathrm{E}_1\tilde{u}_t}{d\bar{i}_1}\right|_{p_t, \mathrm{E}_1\Delta u_t \text{ const.}}, \tag{2.7}$$

$$\mathrm{MB}_t^p \equiv [\mathrm{E}_1(\Delta u_t)^2 + 2\mathrm{E}_1\tilde{u}_t^{\mathrm{n}}\,\mathrm{E}_1\Delta u_t]\,(-\frac{dp_t}{d\bar{i}_1}), \tag{2.8}$$

$$\mathrm{MB}_t^{\Delta u} \equiv 2p_t\,\mathrm{E}_1(\tilde{u}_t^{\mathrm{n}} + \Delta u_t)\,(-\frac{d\mathrm{E}_1\Delta u_t}{d\bar{i}_1}) = 2p_t\,\mathrm{E}_1\tilde{u}_t^{\mathrm{c}}\,(-\frac{d\mathrm{E}_1\Delta u_t}{d\bar{i}_1}), \tag{2.9}$$

$$\mathrm{MB}_t \equiv \mathrm{MB}_t^p + \mathrm{MB}_t^{\Delta u}. \tag{2.10}$$

Here MC_t denotes the (quarter-t) *marginal cost of LAW*. It consists of the marginal increase in the expected quarter-t loss from an increase in the unemployment deviation at constant probability and magnitude of a crisis.[4] Furthermore, MB_t^p denotes the *marginal benefit of LAW from a lower probability of a crisis*. It consists of the marginal reduction of the expected quarter-t loss from a lower probability of a crisis at a constant non-crisis unemployment deviation and a constant magnitude of a crisis. Similarly, $\mathrm{MB}_t^{\Delta u}$ denotes the *marginal benefit of LAW from a smaller magnitude of a crisis*. It consists of the marginal reduction of the expected quarter-t loss from a smaller magnitude of a crisis at constant probability of a crisis and constant non-crisis unemployment deviation. MB_t denotes the total marginal benefit, the sum of the two components.

For a zero (expected) non-crisis unemployment deviation ($\mathrm{E}_1\tilde{u}_t^{\mathrm{n}} = 0$), corresponding to NL, the marginal cost and the two marginal benefits are then given by

$$\mathrm{MC}_t = 2\,p_t \mathrm{E}_1\Delta u_t\,\frac{d\mathrm{E}_1 u_t^{\mathrm{n}}}{d\bar{i}_1}, \tag{2.11}$$

$$\mathrm{MB}_t^p = \mathrm{E}_1(\Delta u_t)^2\,(-\frac{dp_t}{d\bar{i}_1}), \tag{2.12}$$

$$\mathrm{MB}_t^{\Delta u} = 2p_t\,\mathrm{E}_1\Delta u_t\,(-\frac{d\mathrm{E}_1\Delta u_t}{d\bar{i}_1}). \tag{2.13}$$

In order to assess whether or not the costs of LAW exceed the benefits, CB then looks at the sign of the cumulative discounted net marginal cost,

$$\mathrm{NMC} = \sum_{t=1}^{\infty}\delta^{t-1}\mathrm{NMC}_t = \sum_{t=1}^{\infty}\delta^{t-1}\mathrm{MC}_t - \sum_{t=1}^{\infty}\delta^{t-1}\mathrm{MB}_t \gtreqless 0, \tag{2.14}$$

where MC_t is given by (2.11) and MB_t by (2.10), (2.12), and (2.13).[5]

[4] It is assumed that $\mathrm{E}_1(\tilde{u}_t\, du_t^{\mathrm{n}}/d\bar{i}_1) = \mathrm{E}_1\tilde{u}_t\, d\mathrm{E}_1 u_t^{\mathrm{n}}/d\bar{i}_1$, that is, that $\tilde{u}_t$ and $du_t^{\mathrm{n}}/d\bar{i}_1$ are independent conditional on information available in quarter 1. Furthermore, because u_t^* depends on cost-push shocks and is exogenous, $d\mathrm{E}_1\tilde{u}_t^{\mathrm{n}}/d\bar{i}_1 = d\mathrm{E}_1(u_t^{\mathrm{n}} - u_t^*)/d\bar{i}_1 = d\mathrm{E}_1 u_t^{\mathrm{n}}/d\bar{i}_1$.

[5] In practice, CB looks at the undiscounted cumulative net marginal cost ($\delta = 1$). Because the marginal benefits occur further into the future than the marginal cost, this tilts the case somewhat in favor of LAW.

3 Benchmark numbers and the main result

In order to asses whether or not the costs of LAW exceed the benefits, one needs numerical estimates of or assumptions about the components of the marginal cost and benefits in (2.11)-(2.13).

The marginal cost of LAW For a numerical estimate of the marginal cost of LAW, by (2.11) one needs representative estimates of or realistic assumptions about the probability of a crisis, the (expected) magnitude of a crisis, and the policy-rate effect on the (expected) non-crisis unemployment rate.

As a representative *benchmark policy-rate effect on the (expected) non-crisis unemployment rate*, $d\mathrm{E}_1 u_t^{\mathrm{n}}/d\bar{i}_1$, CB uses the impulse response of the Riksbank's empirical DSGE model Ramses to a 1 pp higher policy rate during quarters 1–4, shown as the dashed red line in the lower right part of figure 3.1.[6] The unemployment rate increases above the baseline to about 0.5 pp in quarters 6–8 and then slowly falls back towards the baseline. For an initial zero non-crisis unemployment deviation, the dashed red line then also shows the effect of the policy rate on the non-crisis unemployment deviation.

This impulse response has a typical and realistic hump-shaped form. Because the economy responds with a lag to policy-rate changes, the initial effect is approximately zero and the maximum effect is reached after 6–8 quarters. It is similar in shape and magnitude to the impulse response reported by IMF (2015, para. 40 and footnote 42) for its widely used GIMF model for an average of a large, mostly closed economy and a small open economy.

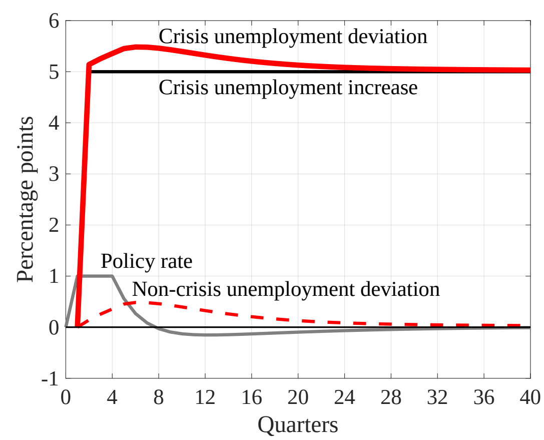

Figure 3.1: The policy-rate effect on the non-crisis and crisis unemployment deviations.

For the *benchmark (expected) crisis increase in the unemployment rate*, $\mathrm{E}_1 \Delta u_t$, representing the magnitude of a crisis, CB for simplicity uses the same assumption as in a crisis scenarios discussed in IMF (2015, para. 41) and in Sveriges Riksbank (2013), that the benchmark crisis increase in the unemployment rate is deterministic and constant and equal to 5 pp.

For a *zero* non-crisis unemployment deviation, if a crisis occurs, the unemployment deviation will

[6] The figure shows the impulse response for 40 quarters of the unemployment rate that was reported by then Riksbank Deputy Governor Karolina Ekholm in Ekholm (2013). It is the same response as the one reported to alternative policy-rate paths for quarters 1–12 in Sveriges Riksbank (2014b).

then increase to a crisis unemployment deviation of 5 pp, shown by the solid black horizontal line in the upper right part of figure 3.1. Furthermore, with LAW and a *positive* non-crisis unemployment deviation, if a crisis occurs, the unemployment deviation will increase *above* 5 pp, as shown by the thick solid red line in the figure. Importantly, LAW leads to a higher *crisis* unemployment deviation, not only to a higher *non-crisis* unemployment deviation.

It remains to specify the *benchmark probability of a crisis*, p_t. CB assumes that there is a benchmark constant annual probability of a crisis start equal to 3.2%, corresponding to a crisis on average every 31 years. Let q_t denote the (quarterly) probability of crisis start in quarter t. The *benchmark (quarterly) probability of a crisis start* is thus $q_t = 3.2\%/4 = 0.8\%$.

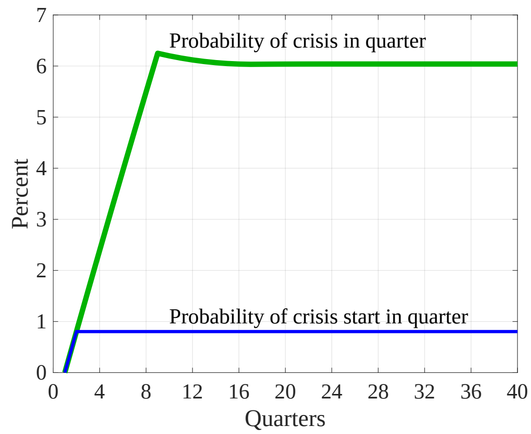

Figure 3.2: The benchmark probabilities of a crisis and a crisis start.

Let n denote the crisis duration measured in quarters. The *benchmark crisis duration* is assumed to be $n = 8$ quarters. In figure 3.2, the thin blue and thick green lines show the benchmark probability of a crisis start and benchmark probability of a crisis in future quarters, conditional on no crisis in quarter 1. The probability of a crisis is equal to the probability of a crisis starting in the last n quarters. As explained in CB (appendix C), the exact probability of a crisis is given by a Markov process. It is close to a simple linear approximation equal to the sum of the probabilities of a crisis start over the last n quarters, $p_t \approx \sum_{\tau=0}^{n-1} q_{t-\tau}$.

All the components of the benchmark marginal cost, (2.11), have now been specified. It is shown as the thin the red line marked MC in figure 3.3.

The marginal benefit For the benchmark marginal benefit from a lower probability of a crisis, (2.12), one needs an estimate of the policy-rate effect on the probability of a crisis, $dp_t/d\bar{i}_1$, which in turn depends on the policy-rate effect on the probability of a crisis start, $dq_t/d\bar{i}_1$, as shown in CB (appendix C). For a benchmark estimate of the latter, CB combines a benchmark estimate of the effect of debt on the probability of a crisis start of Schularick and Taylor (2012) with a benchmark estimate of the policy-rate effect on debt of Sveriges Riksbank (2014a).[7]

[7] IMF (2015, para. 24 and footnote 19) summarizes the estimates of this effect in several papers. It notes that "real debt levels generally decrease following a temporary monetary policy tightening of 100 bp, by up to 0.3% and 2%, after 4 to 16 quarters, depending on the model" and that "Sveriges Riksbank (2014a) comes to a middle-of-the-road result."

Schularick and Taylor (2012) find that the probability of a crisis start depends on lagged real debt growth. Under the realistic assumption of monetary neutrality, monetary policy has no long-run effect on real debt and thereby no long-run effect on real debt growth. Then the cumulative policy-rate effect on real debt growth is small or zero. Monetary policy can only shift the probability between periods; reduce it in some quarters and increase it in others. It cannot reduce the cumulative probability. It follows that the marginal benefit from a lower probability of crisis will be positive in some periods and negative in other periods. The cumulative marginal benefit of LAW from a lower probability of a crisis will be small or zero.

In order to stack the cards in favor of LAW, I here instead make the less realistic assumption that monetary policy has a permanent rather than temporary effect on real debt and modify the Sveriges Riksbank (2014a) estimate accordingly, as in one of the robustness tests in CB (section 4 and figure 7). Then the marginal benefit from a lower probability is never negative, and the cumulative marginal benefit from a lower probability is positive.

In order to find a numerical estimate of the marginal benefit from a smaller magnitude of a crisis, (2.13), one needs to find an estimate of the policy-rate effect on the magnitude of a crisis. A possible channel is the effect of debt on the magnitude of a crisis combined with the policy-rate effect on debt. For the former, CB uses the estimate of Flodén (2014). He finds for the OECD countries that a lower household debt-to-income ratio in 2007 is associated with a lower increase in the unemployment rate during 2007-2012. As shown in CB, Flodén's estimate of the effect of debt to income on the magnitude of a crisis is similar to the estimates of Jordà et al. (2013) and Krishnamurthy and Muir (2016). For the policy-rate effect on debt to income CB uses the Sveriges Riksbank (2014a) estimate. As discussed in CB, this estimate appears to be too large, but in order to stack the cards in favor of LAW, it is nevertheless used.

The net marginal cost The sum of the marginal benefits from a lower probability and smaller magnitude of a crisis for these assumptions and estimates is shown as the the green line marked MB in figure 3.3. The net marginal cost, the difference between the marginal cost and the marginal benefit, is shown as the thick blue line marked NMC.

The main result Figure 3.4 shows the corresponding (undiscounted) cumulative marginal cost, marginal benefit, and net marginal cost. (Because the main marginal benefit occurs later than the main marginal cost, not discounting stacks the cards in favor of LAW.)[8] Clearly, the cumulative

[8] The undiscounted cumulative discounted net marginal cost is the limit of (2.14) for $\delta \to 1-$.

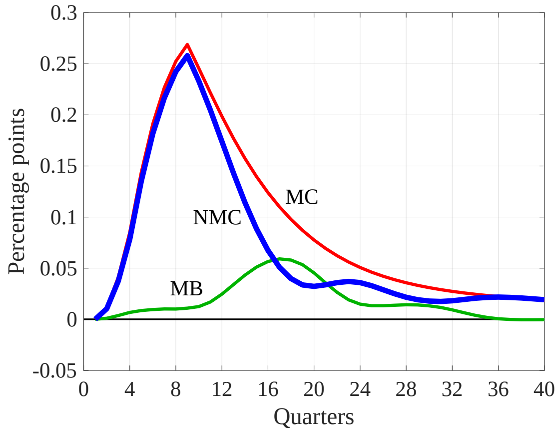

Figure 3.3: The marginal cost (MC), marginal benefits from a lower probability and smaller magnitude of a crisis (MB), and net marginal cost (NMC) for the case of monetary non-neutrality and a permanent policy-rate effect on real debt.

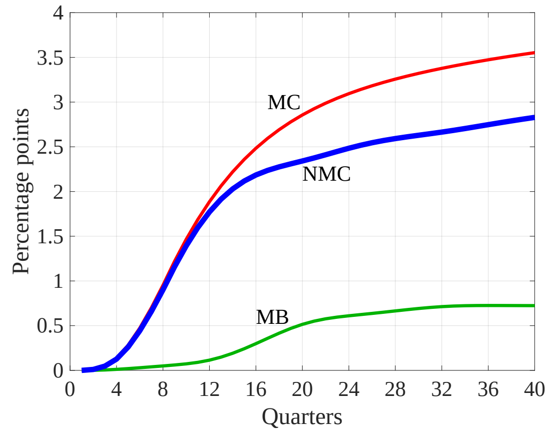

Figure 3.4: The cumulative marginal cost (MC), marginal benefits from a lower probability and smaller magnitude of a crisis (MB), and net marginal cost (NMC) for the case of monetary non-neutrality and a permanent policy-rate effect on real debt.

marginal cost exceeds the cumulative marginal benefit by a substantial margin.

The result is thus robust to monetary non-neutrality and a permanent policy-rate effect on real debt. As shown in CB, it is also robust to a smaller policy-rate effect on unemployment; a credit boom with a higher probability of a crisis; a larger crisis magnitude; a longer crisis duration; larger policy-rate effects on the probability and duration of a crisis; less effective macroprudential policy; and using debt to GDP as in Schularick and Taylor (2012, table 4, specification 9), including 5-year moving averages in Jordà et al. (2016), instead of real debt as a predictor of crises. In particular, to overturn the result, the policy-rate effects on the probability and magnitude of a crisis need to be more than 5–40 standard errors larger than the representative benchmark point estimates, in spite of some of the estimates having large standard errors relative to the point estimates. This all indicates that the result is quite robust.

4 Alternative assumptions about the crisis loss level and the cost of a crisis

The framework laid out in section 2 has the realistic property that the cost of a crisis (the crisis loss less the non-crisis loss) is larger if the economy is initially weak in the sense having a positive non-crisis unemployment deviation, that is, a higher non-crisis unemployment rate than the optimal benchmark unemployment rate. This results from the assumption that the crisis unemployment deviation satisfies (2.4), where the crisis increase in the unemployment rate, Δu_t, is independent of the non-crisis unemployment deviation, $\tilde{u}_t^{\mathrm{n}}$. This means that the cost of a crisis is given by

$$\Delta L_t \equiv L_t^{\mathrm{c}} - L_t^{\mathrm{n}} = (\tilde{u}_t^{\mathrm{n}} + \Delta u_t)^2 - (\tilde{u}_t^{\mathrm{n}})^2 = (\Delta u_t)^2 + 2\,\tilde{u}_t^{\mathrm{n}}\,\Delta u_t, \tag{4.1}$$

the expectation of which equals expression in square brackets on the right side of (2.6). It follows that the cost of a crisis is increasing in the non-crisis unemployment deviation.

Here we shall look at two alternative and arguably less realistic assumptions used in the literature. The first is that the crisis *loss level* is independent of the non-crisis unemployment deviation; the second is that *cost of a crisis* (the crisis loss less the non-crisis loss) is independent of the non-crisis unemployment deviation.

4.1 The *crisis loss level* independent of the non-crisis unemployment deviation

The first alternative assumption can be represented by the assumption that a crisis does not mean that the unemployment deviation *increases* by Δu_t; instead the crisis unemployment deviation *reaches* Δu_t, independent of the non-crisis unemployment deviation. That is,

$$\tilde{u}_t^{\mathrm{c}} = \Delta u_t \tag{4.2}$$

instead of (2.4), and the crisis loss is given by

$$L_t^{\mathrm{c}} = (\tilde{u}_t^{\mathrm{c}})^2 = (\Delta u_t)^2 \tag{4.3}$$

instead of (2.5). Here Δu_t should now be interpreted as the unemployment-gap equivalent of the crisis loss *level* rather than the crisis increase in the unemployment rate. Then the cost of a crisis satisfies

$$\Delta L_t \equiv L_t^{\mathrm{c}} - L_t^{\mathrm{n}} = (\Delta u_t)^2 - (\tilde{u}_t^{\mathrm{n}})^2 \tag{4.4}$$

insted of (4.1). It follows that the assumption has the strange implication that the cost of a crisis is *decreasing* in the non-crisis loss. In particular, if the economy initially has a non-crisis unemployment deviation above Δu_t, it would be better off in a crisis, because the unemployment deviation would then drop to Δu_t.

In terms of figure 3.1, the assumption means that the crisis unemployment deviation is 5 pp, given by the horizontal black line in the upper right part of the figure, and the crisis loss level is $L_t^{\mathrm{c}} = 5^2 = 25$, regardless of the non-crisis unemployment deviation.

The assumption has been used by Ajello et al. (2016), Diaz Kalan et al. (2015), IMF (2015), and Svensson (2014, 2015). It has normally been combined with the assumption that any crisis would occur in the future when the expected non-crisis unemployment deviation would be zero (for example, that the economy has reached a situation where the unemployment gap is zero and inflation is on target), in which case the crisis increase and the crisis level of the unemployment deviation would both be Δu_t. But, as we have seen in the lower right part of figure 3.1, with LAW the non-crisis unemployment deviation could be higher for several years during which a crisis may occur.

The expected quarter-t loss then satisfies

$$\mathrm{E}_1 L_t = (1-p_t)\mathrm{E}_1 L_t^{\mathrm{n}} + p_t \mathrm{E}_1 L_t^{\mathrm{c}} = (1-p_t)\mathrm{E}_1(\tilde{u}_t^{\mathrm{n}})^2 + p_t\, \mathrm{E}_1(\Delta u_t)^2 \tag{4.5}$$

instead of (2.6). The corresponding marginal cost of LAW and marginal benefits from lower probability and magnitude of a crisis satisfy

$$\mathrm{MC}_t \equiv 2\,(1-p_t)\mathrm{E}_1 \tilde{u}_t^{\mathrm{n}} \frac{d\mathrm{E}_1 u_t^{\mathrm{n}}}{d\bar{i}_1}, \tag{4.6}$$

$$\mathrm{MB}_t^p \equiv \mathrm{E}_1(\Delta u_t)^2\,(-\frac{dp_t}{d\bar{i}_1}), \tag{4.7}$$

$$\mathrm{MB}_t^{\Delta u} \equiv 2p_t\, \mathrm{E}_1 \Delta u_t\,(-\frac{d\mathrm{E}_1 \Delta u_t}{d\bar{i}_1}), \tag{4.8}$$

instead of (2.7)-(2.9).

We see that the marginal cost depends on the probability of a non-crisis times the expected non-crisis unemployment deviation, $(1-p_t)\mathrm{E}_1\tilde{u}_t^{\mathrm{n}}$, in (4.6) rather than the expected unemployment deviation, $\mathrm{E}_1\tilde{u}_t = (1-p^{\mathrm{n}})\mathrm{E}_1\tilde{u}_t^{\mathrm{n}} + p_t\,\mathrm{E}_1\tilde{u}_t^{\mathrm{c}}$, in (2.7). It follows that for a zero expected non-crisis unemployment deviation, the marginal cost will be zero, not positive as in (2.7). Then, if the marginal benefit is positive, *some* positive LAW will be optimal. But we will see that the optimal LAW will be quite small.

We continue to stack the cards in favor of LAW by assuming monetary non-neutrality and a permanent policy-rate effect on real debt, so that the cumulative marginal benefit from a lower probability of a crisis is not approximately zero but positive. Let me also retain the benchmark assumption that $\Delta u_t = 5$ pp, although with the different interpretation that Δu_t now represents the crisis unemployment deviation. The corresponding marginal cost, marginal benefit, and net marginal cost (NMC) for a zero non-crisis unemployment deviation, corresponding to NL, are shown in figure 4.1. The marginal cost is flat at zero. The marginal benefit is the same as in figure 3.3. The net marginal cost equals the negative of the positive marginal benefit.

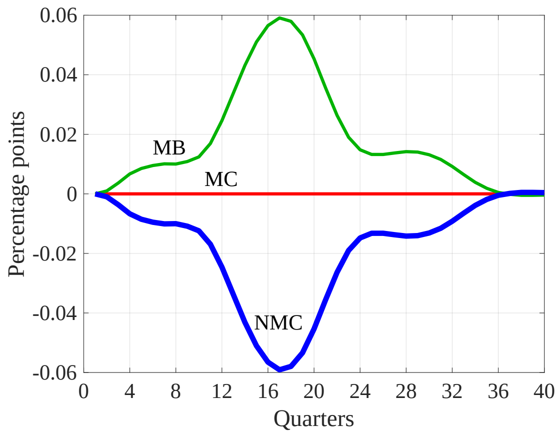

Figure 4.1: For the assumption of an independent crisis loss level, the marginal cost (MC), marginal benefit (MB), and net marginal cost (NMC); permanent effect on real debt.

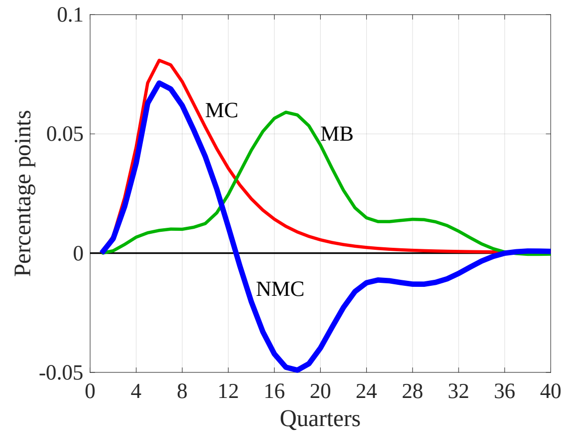

Figure 4.2: For the assumption of a crisis loss level independent of LAW and a policy-rate increase of 18 bp, the marginal cost (MC), marginal benefit (MB), and net marginal cost (NMC); permanent effect on real debt.

Because the marginal cost (4.6) is rising relatively fast in the non-crisis unemployment deviation and the marginal benefit is small, a quite small increase in the policy-rate is sufficient to raise the (expected) non-crisis unemployment deviation so that the marginal cost becomes positive and the cumulative marginal cost equals the cumulative marginal benefit, corresponding to (approximately) optimal LAW. Indeed, a policy-rate increase $\Delta\bar{i}_1$ of only 18 bp during quarters 1–4 is sufficient, which will raise the expected non-crisis unemployment deviation to about 9 bp in quarters 6–8 (18% of the benchmark policy-rate effect on the non-crisis unemployment deviation in figure 3.1). The resulting marginal cost, marginal benefit and net marginal cost are shown in figure 4.2. Here the cumulative marginal cost and benefit are approximately equal and the cumulative net marginal cost is approximately zero after about 40 quarters.

Under monetary neutrality, the cumulative marginal benefit is smaller, because the cumulative marginal benefit of a fall in the probability of a crisis is approximately zero. It can be shown that then a policy-rate increase of only 4 bp is sufficient to make the cumulative marginal cost equal the cumulative marginal benefit.

These results are consistent with the main result in Ajello et al. (2016) that the optimal LAW is quite small. In their case it corresponds to a policy-rate increase of no more than 6 bp. Thus, even though, for this alternative assumption and loss function, the marginal cost of LAW initially is zero and some LAW thus is optimal, the approximately optimal LAW is so small that it is clearly of no practical significance.

4.2 The *cost of a crisis* independent of the non-crisis unemployment deviation

A second alternative assumption is that the the cost of a crisis (the crisis loss less the non-crisis loss), is independent of whether the economy is initially weak or not. It has been used by Filardo and Rungcharoenkitkul (2016, section 4) and Gourio et al. (2017). This assumption can be represented by the cost of a crisis satisfying

$$\Delta L_t \equiv L_t^{\mathrm{c}} - L_t^{\mathrm{n}} = (\Delta u_t)^2, \tag{4.9}$$

where Δu_t now represents the unemployment-gap equivalent of the crisis loss *increase* rather than the crisis increase in the unemployment rate.[9]

Then the expected quarter-t loss and marginal cost satisfy

$$\mathrm{E}_1 L_t = (1 - p_t)\mathrm{E}_1 L_t^{\mathrm{n}} + p_t \mathrm{E}_1 L_t^{\mathrm{c}} = \mathrm{E}_1 L_t^{\mathrm{n}} + p_t \mathrm{E}_1 \Delta L_t = \mathrm{E}_1(\tilde{u}_t^n)^2 + p_t \mathrm{E}_1 (\Delta u_t)^2, \tag{4.10}$$

$$\mathrm{MC}_t \equiv 2\,\mathrm{E}_1 \tilde{u}_t^{\mathrm{n}} \frac{d\mathrm{E}_1 u_t^{\mathrm{n}}}{d\bar{i}_1}, \tag{4.11}$$

whereas the marginal benefits from a fall in the probability and magnitude of a crisis are still given by (4.7) and (4.8). The only difference between (4.6) and (4.11) is that the latter is slightly larger because it is multiplied by unity instead of $1 - p_t$, the probability of a non-crisis in quarter t, which for the benchmark assumptions equals 0.94 in steady state (see figure 3.2).

Thus, the marginal cost is still zero for a zero expected non-crisis unemployment deviation, so some LAW is optimal. But because the marginal cost is slightly larger than for the first alternative, the (approximately) optimal policy-rate increase and LAW is slightly smaller. Under the assumption of non-neutrality and a permanent policy-rate effect on real debt, the optimal policy rate increase is $\Delta\bar{i}_1 = 17$ bp, slightly smaller than for the first alternative. The difference would hardly be noticeable in figures 4.1 and 4.2.

The small optimal LAW is consistent with the results of Gourio et al. (2017, table 2). They find that the optimal LAW in their case is to reduce the annual probability of a crisis by 7 bp from 2.06% to 1.99%, implying on average one crisis in 50.3 years instead of one in 48.5 years. In the present paper, under monetary non-neutrality, the average reduction in the annual probability of a crisis over 40 quarters is 22 bp for a 1 pp higher policy rate during quarters 1–4. Then a 17 bp higher policy rate implies an average reduction in the annual probability of a crisis of $0.17 \cdot 22 = 4$ bp, rather similar to the GKS result.

[9] Thus, the interpretation of $d\mathrm{E}_1\Delta u_t/d\bar{i}_1$ is now different from the one in Flodén (2014). I nevertheless use his estimate so as to make the marginal benefit from a smaller magnitude of a crisis positive (in Filardo and Rungcharoenkitkul (2016) and Gourio et al. (2017) that marginal benefit is zero because the magnitude of a crisis is assumed exogenous).

In summary, the two alternative but arguably less realistic assumptions make the marginal cost of LAW be zero for a zero expected non-crisis unemployment deviation, making some LAW optimal. However, as already shown by Ajello et al. (2016) and indicated by the main result of Gourio et al. (2017), the optimal LAW is too small to be of any practical relevance.

5 Conclusions

LAW has costs in terms of a weaker economy with higher unemployment and possible benefits in and possible benefits in the form of a lower probability and smaller magnitude of a crisis. We have seen that the assumptions about the costs of LAW matter for a cost-benefit analysis of LAW, in particular for the marginal cost of LAW in a situation of no leaning (NL), where NL refers to optimal monetary policy under flexible inflation targeting when the probability of a crisis is set to zero. Under the arguably realistic assumption that the loss in a crisis and the cost of a crisis (the crisis loss less the non-crisis loss) are higher for a given magnitude of a crisis if the economy initially is weaker due to LAW, the marginal cost of LAW is positive. For representative empirical benchmark estimates the marginal cost then exceeds the marginal benefit by a substantial margin.

Under the arguably less realistic assumptions that, for a given magnitude of a crisis, either the loss in a crisis or the cost of a crisis is independent of whether the economy is initially weaker due to LAW, the marginal cost of LAW is zero at an initial situation of NL. Then *some* positive LAW is optimal. However, for representative empirical benchmark estimates, the marginal benefit is small and the marginal cost is increasing relatively fast. Then the optimal amount of LAW is quite small. In particular, it is too small to be economically significant.

References

Ajello, Andrea, Thomas Laubach, David Lopez-Salido, and Taisuke Nakata (2016), "Financial Stability and Optimal Interest-Rate Policy," Finance and Economics Discussion Series 2016-067, Federal Reserve Board.

Allen, Franklin, Charles Bean, and José De Gregorio (2016), "Independent Review of BIS Research: Final Report," Report, available at www.bis.org.

BIS (2014), *84th Annual Report*, Bank for International Settlements.

BIS (2016), *86th Annual Report*, Bank for International Settlements.

Diaz Kalan, Federico, Stefan Laséen, David Vestin, and Aleksandra Zdzienicka (2015), "Leaning Against the Wind: A Note on Costs and Benefits," Working Paper, International Monetary Fund, in progress.

Ekholm, Karolina (2013), "Stabiliseringspolitiken och arbetslösheten (Stabilization Policy and Unemployment, in Swedish)," Presentation at LO, Stockholm, June 19, 2013, Sveriges Riksbank, available at www.LO.se.

Filardo, Andrew, and Phurichai Rungcharoenkitkul (2016), "Quantitative Case for Leaning Against the Wind," BIS Working Paper No. 594, Bank for International Settlements.

Flodén, Martin (2014), "Did Household Debt Matter in the Great Recession?" Supplement to blog post on Ekonomistas.se, available at www.martinfloden.net/files/hhdebt_replicate.zip.

Gourio, François, Anil K. Kashyap, and Jae Sim (2017), "The Tradeoffs in Leaning Against the Wind," NBER Working Paper No. 23568.

IMF (2015), "Monetary Policy and Financial Stability," Staff Report, International Monetary Fund.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor (2013), "When Credit Bites Back," *Journal of Money, Credit and Banking* 45, Supplement(2), 3–28.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor (2016), "The Great Mortgaging: Housing Finance, Crises and Business Cycles," *Economic Policy* 31(85), 107–152.

Krishnamurthy, Arvind, and Tyler Muir (2016), "How Credit Cycles across a Financial Crises," Working Paper, available at people.stanford.edu/akris/.

Olsen, Øystein (2015), "Integrating Financial Stability and Monetary Policy Analysis," Speech at the London School of Economics, London, April 27, 2015, Norges Bank.

Schularick, Moritz, and Alan M. Taylor (2012), "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008," *American Economic Review* 102, 1029–1061.

Svensson, Lars E.O. (2014), "Inflation Targeting and 'Leaning Against the Wind'," *International Journal of Central Banking* 10(2), 103–114.

Svensson, Lars E.O. (2015), "Inflation Targeting and Leaning Against the Wind," in *Fourteen Years of Inflation Targeting in South Africa and the Challenge of a Changing Mandate: South African Reserve Bank Conference Proceedings 2014*, South African Reserve Bank, pages 19–36, available at www.larseosvensson.se.

Svensson, Lars E.O. (2016a), "Cost-Benefit Analysis of Leaning Against the Wind: Are Costs Larger Also with Less Effective Macroprudential Policy?" IMF Working Paper WP/16/03, International Monetary Fund, available at www.imf.org.

Svensson, Lars E.O. (2016b), "Discussion (revised) of Filardo and Rungcharoenkitkul, Quantitative Case for Leaning-Against-the-Wind," Research Forum on Macro-Finance, Centre for Central Banking Studies, Bank of England, May 26-27, Stockholm School of Economics, available at www.larseosvensson.se.

Svensson, Lars E.O. (2017), "Cost-Benefit Analysis of Leaning Against the Wind," *Journal of Monetary Economics* 90(October 2017), 193–213, available at www.larseosvensson.se.

Sveriges Riksbank (2013), "Financial Imbalances in the Monetary Policy Assessment," *Monetary Policy Report July 2013* .

Sveriges Riksbank (2014a), "The Effects on Monetary Policy on Household Debt," *Monetary Policy Report February 2014* .

Sveriges Riksbank (2014b), *Monetary Policy Report February 2014*, Sveriges Riksbank.