Leaning Against the Wind: Costs and Benefits, Effects on Debt, Leaning in DSGE Models, and a Framework for Comparison of Results[*]

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The simple and transparent framework for cost-benefit analysis of leaning against the wind (LAW) in Svensson (2017a) and its main result are summarized. The analysis of the policy-rate effects on debt in Bauer and Granziera (this issue) does not seem to contradict that the effects may be small and of either sign. The analysis of LAW in DSGE models is complicated and the results of Gerdrup et al. (this issue) may not be robust. The Svensson (2017a) framework may allow comparison and evaluation of old and new approaches and their results. As an example, it is shown that these three papers result in very different marginal costs of LAW and that a realistic policy-rate effect on unemployment is crucial.

JEL Codes: E52, E58, G01.

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) crises (Bank for

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International Settlements 2014, 2016; Olsen 2015; Sveriges Riksbank 2013).

In particular, the BIS has been a strong proponent of LAW, although, strikingly, without the support of a credible numerical cost-benefit analysis, as noted in an independent review of BIS research, Allen, Bean, and De Gregorio (2016, p. 19):

> Although the BIS was an early proponent of using macro-prudential policies to manage the credit cycle, much of the associated BIS research and policy advice continued to focus instead on the use of LAW in monetary policy to mitigate financial stability risks. Indeed, in the outside world, this is—for better or worse—the view that the BIS is probably most associated with. Yet so far the argument for LAW seems to have cut relatively little ice with those actually responsible for setting monetary policy. In part, that is because of the lack of convincing evidence that the expected benefits outweigh the expected costs.

Instead, such cost-benefit analysis has been undertaken outside the BIS, for example, by Ajello et al. (2016), International Monetary Fund (2015), and Svensson (2014), with a rather unfavorable outcome for LAW. The extensive study in the policy paper IMF (2015) concludes:

> The question is whether monetary policy should be altered to contain financial stability risks. . . . Based on our current knowledge, and in present circumstances, the answer is generally no.

After a thorough discussion of the evidence by the Federal Open Market Committee at its April 2016 meeting, the minutes, FOMC (2016), summarize:

> Most participants judged that the benefits of using monetary policy to address threats to financial stability would typically be outweighed by the costs . . . ; some also noted that the benefits are highly uncertain.

Previously, San Francisco Federal Reserve Bank President Williams (2015) had concluded:

> Monetary policy is poorly suited for dealing with financial stability, even as a last resort.

More recently, my paper Svensson (2017a) (CB for short) (first version Svensson 2016) provides a simple and transparent framework for a cost-benefit analysis of LAW and benchmark numerical estimates of its costs and benefits. The result is that, for existing representative estimates, 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 five to forty standard errors larger than the typical empirical estimates in the literature.

2. Costs and Benefits of LAW

The framework of CB can be summarized as follows: It examines the effect of LAW on the expected discounted loss, $E_1 \sum_{t=1}^{\infty} \delta^{t-1} L_t = \sum_{t=1}^{\infty} \delta^{t-1} E_1 L_t$, where E_1 denotes expectations in quarter 1, δ is a discount factor, and L_t is the quarter-t loss. The expected quarter-t loss satisfies

$$E_1 L_t = (1 - p_t) E_1 (\tilde{u}_t^n)^2 + p_t \, E_1 (\tilde{u}_t^n + \Delta u_t)^2$$
$$= E_1 (\tilde{u}_t^n)^2 + p_t \, [E_1 (\Delta u_t)^2 + 2 E_1 \tilde{u}_t^n \, E_1 \Delta u_t]. \qquad (1)$$

In quarter $t \geq 2$ there can be either of two states of the world, either a non-crisis or a (financial) crisis, denoted n and c, respectively. 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 $\tilde{u}_t^n$ denotes the quarter-t non-crisis unemployment deviation. It is the deviation in the non-crisis state of the actual unemployment rate from the unemployment rate that is optimal under flexible inflation targeting when the possibility of a crisis is disregarded. Then the first term after the first equality sign of (1) is the probability of no crisis, $1 - p_t$, times the expected non-crisis loss, $E_1 L_t^n = E_1 (\tilde{u}_t^n)^2$, the expected loss if there is no crisis in quarter t.[1]

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[1] As shown in CB (appendix A), the quadratic loss function $L_t = (\tilde{u}_t)^2$ is an *indirect* loss function of deviations from the optimal policy under flexible inflation targeting when the possibility of a crisis is disregarded. It takes into account a Phillips curve and the loss from inflation deviating from the inflation target.

The second term after the first equality sign is the probability of a crisis times the expected crisis loss, $E_1 L_t^c = E_1(\tilde{u}_t^c)$, 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, $\Delta u_t > 0$, so the crisis unemployment deviation is $\tilde{u}_t^c = \tilde{u}_t^n + \Delta u_t$, and the crisis loss is $L_t^c = (\tilde{u}_t^n + \Delta u_t)^2$. 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 restriction on the policy response such as the lower bound of the policy rate. It represents the *magnitude of a crisis*. The benchmark assumption is that it equals 5 percentage points and that the duration of a crisis is eight quarters.
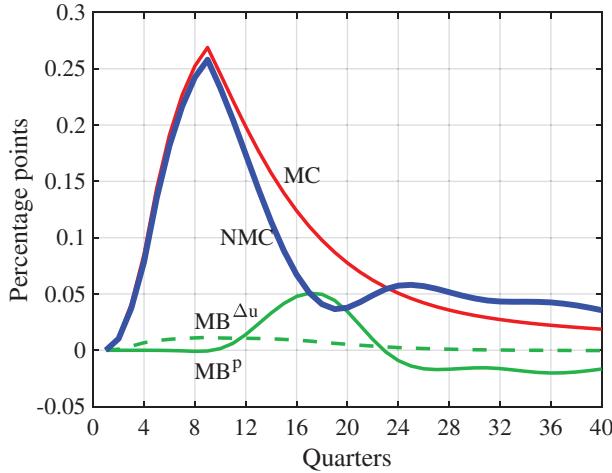
The expected quarter-t loss can be rewritten as the expression after the second equality sign in (1). There, the expression in square brackets is the expected cost of a crisis, defined as the expected crisis loss less the expected non-crisis loss. The expected cost of a crisis is increasing in the expected non-crisis unemployment deviation, $E_1 \tilde{u}_t^n$.

LAW is represented by an increase in the policy rate during quarters 1–4, denoted $d\bar{\imath}_1 > 0$. This increases the non-crisis unemployment gap, $\tilde{u}_t^n$. This in turn has two costs of LAW. The *first* is an increase in the non-crisis loss, $L_t^n = (\tilde{u}_t^n)^2$. The *second*—less obvious, overlooked by the previous literature, but higher—is an increase in the crisis loss, $L_t^c = (\tilde{u}_t^n + \Delta u_t)^2$. A possible benefit of LAW is from a lower probability of a crisis, p_t, which will reduce the second term after the second equality in (1), the expected cost of a crisis, $p_t(E_1 L_t^c - E_1 L_t^n)$. A second possible benefit is from a smaller magnitude of a crisis, Δu_t, which will reduce the expected crisis loss, $E_1 L_t^c = E_1(\tilde{u}_t^n + \Delta u_t)^2$.

For an initial zero expected non-crisis unemployment deviation ($E_1 \tilde{u}_t^n = 0$), corresponding to an initial situation of no leaning, the effect of LAW on the quarter-t expected loss is then taken to be the derivate $dE_1 L_t / d\bar{\imath}_1 = MC_t - MB_t^p - MB_t^{\Delta u_t} \equiv NMC_t$, where

$$MC_t = 2\, p_t E_1 \Delta u_t \, \frac{dE_1 u_t^n}{d\bar{\imath}_1}, \tag{2}$$

**Figure 1. The Marginal Cost, Marginal Benefits
from a Lower Probability and Smaller Magnitude
of a Crisis, and Net Marginal Cost**

$$\mathrm{MB}_t^p = \mathrm{E}_1(\Delta u_t)^2 \left(-\frac{dp_t}{d\bar{\imath}_1}\right), \tag{3}$$

$$\mathrm{MB}_t^{\Delta u} = 2p_t \, \mathrm{E}_1 \Delta u_t \left(-\frac{d\mathrm{E}_1 \Delta u_t}{d\bar{\imath}_1}\right). \tag{4}$$

Here NMC_t denotes the net marginal cost of LAW, MC_t denotes the marginal cost, and MB_t^p and $\mathrm{MB}_t^{\Delta u}$ denote the marginal benefits from, respectively, a lower probability and a smaller magnitude of a crisis. Furthermore, $d\mathrm{E}_1 u_t^{\mathrm{n}}/d\bar{\imath}_1$, $dp_t/d\bar{\imath}_1$, and $d\mathrm{E}_1 \Delta u_t/d\bar{\imath}_1$ denote the policy-rate effects on (that is, the impulse responses of), respectively, the non-crisis unemployment rate, the probability of a crisis, and the magnitude of a crisis. In particular, the benchmark estimate of the policy-rate effect on the non-crisis unemployment rate is a representative hump-shaped impulse response that reaches a maximum of about 0.5 percentage point in quarter 6 and then slowly falls back to the baseline.

The main result of CB is illustrated in figures 1 and 2 (CB, figures 5 and 6). Figure 1 shows the marginal cost, marginal benefits, and net marginal cost of a 1 percentage point higher policy rate

during quarters 1–4 than what is optimal under flexible inflation targeting when the possibility of a financial crisis is disregarded. The marginal cost, (2), is positive and substantial because of the second cost of LAW, that the expected crisis loss for a given magnitude of a crisis, $\mathrm{E}_1 L_t^{\mathrm{c}} = \mathrm{E}_1(\tilde{u}_t^{\mathrm{n}} + \Delta u_t)^2$, is higher with LAW. It is higher because the crisis would occur when the economy is initially weak, with higher unemployment and lower inflation, due to LAW. For the first cost of LAW, the marginal cost is zero when the initial non-crisis unemployment deviation is zero.[2]

The marginal benefit from a lower probability of a crisis, (3), is due to a representative estimate of a negative policy-rate effect on real debt growth and the effect estimated by Schularick and Taylor (2012) of real debt growth on the probability of a crisis (shown in CB, figure 3). The marginal benefit peaks in quarter 17 but then falls and turns negative after quarter 23. The reason it turns negative is that monetary policy is neutral and does not affect real debt in the long run. Then lower real debt growth and a lower probability of a crisis for some years must be followed by higher real debt growth and a higher probability of a crisis.

The marginal benefit from a lower magnitude of a crisis, (4), is due to a negative policy-rate effect on the debt-to-GDP ratio and the effect estimated of debt to income by Flodén (2014) and of debt to GDP by Jordà, Schularick, and Taylor (2013) on the magnitude of a crisis (shown in CB, figure 4).[3]
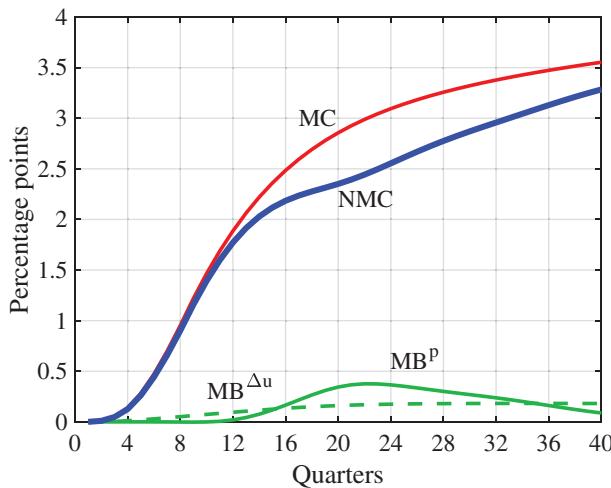
Figure 2 shows the cumulative marginal cost, marginal benefits, and net marginal cost. Clearly, this marginal cost of LAW exceeds the marginal benefit by a substantial margin.

This result is robust to monetary policy being non-neutral and having a permanent effect on real debt. Then the marginal benefit from a lower probability does not turn negative as in figure 1.

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[2]Svensson (2017c) discusses the (arguably less realistic) assumptions in the previous literature about the crisis loss that disregard the second cost of LAW. They imply that the marginal cost of LAW is zero in an initial situation of no leaning. This means that *some* LAW is optimal, if benefits are positive. However, it is shown that, because the marginal cost rises rather quickly, the optimal LAW is quite small and hardly economically significant.

[3]The negative policy-rate effect on the debt-to-GDP ratio used is rather large, so as to tilt the case somewhat in favor of LAW.

Figure 2. The Cumulative Marginal Cost, Marginal Benefits from a Lower Probability and Smaller Magnitude of a Crisis, and Net Marginal Cost
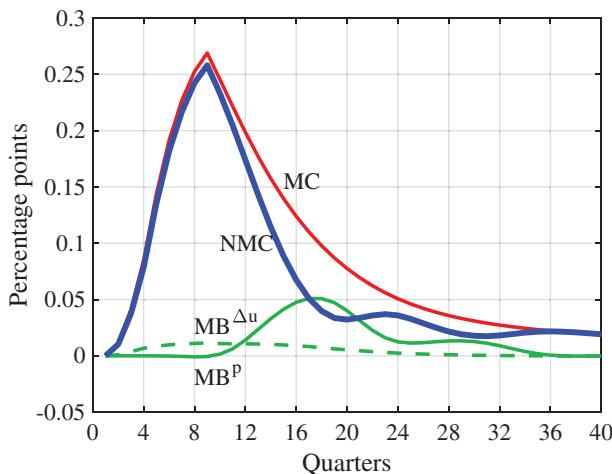

The marginal cost and benefits under a permanent effect on debt is shown in figure 3.

The result 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; less effective macroprudential policy; larger policy-rate effects on the probability and duration of a crisis; and using debt to GDP, including five-year moving averages, instead of real debt as a predictor of crises.[4] In particular, as mentioned, to overturn the result, the policy-rate effects on the probability and magnitude of a crisis need to be more than five to forty standard errors larger than the representative point estimates,

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[4]Schularick and Taylor (2012) report a specification where the annual growth of real debt in the logistic function is replaced by the annual growth of debt to income. Jordà, Schularick, and Taylor (2016) use a five-year moving average of the annual growth of debt to income. Using the debt-to-GDP ratio instead of real debt or using five-year moving averages of it instead of five lags leads to a policy-rate effect on the probability of a crisis and a marginal benefit from a lower probability of a crisis similar to the one in figures 1 and 2. Thus, the cumulative marginal cost still exceeds the cumulative marginal benefit by a substantial margin.

**Figure 3. The Marginal Cost, Marginal Benefits
from a Lower Probability and Smaller Magnitude
of a Crisis, and Net Marginal Cost; Permanent
Policy-Rate Effect on Real Debt**

in spite of some of the estimates having large standard errors relative to the point estimates. Altogether, this indicates that the result is quite robust.

This contradicts Adrian and Liang (2018), who state that "[Svensson's] result that costs exceed benefits relies critically on assumptions about the change in unemployment in a recession or crisis, the crisis probability, and the elasticity of crisis probability with respect to the interest rate," and provide alternative assumptions that they assert would overturn the result. But Svensson (2017b) shows that their alternative assumptions are hardly realistic: they exceed existing empirical estimates by more than eleven, thirteen, and forty standard errors.

Given the simplicity and transparency of the framework and its dependence on only a few assumptions and empirical estimates of the policy-rate effects on unemployment and the probability and magnitude of a crisis, it is easy to redo the analysis with alternative assumptions or new alternative or better empirical estimates. This way the robustness of the result can be further examined.

3.   The Policy-Rate Effect on Debt

As discussed in Svensson (2013), the policy-rate effect on real debt and the debt-to-GDP ratio is likely to be small and could be of either sign. The stock of nominal debt, especially mortgages with long maturities, has considerable inertia. A higher policy rate may slow down the growth of housing prices and of new mortgages, but only a fraction of the stock of mortgages is turned over each year. A higher policy rate also slows down the growth of the price level. Thus, both numerator and denominator of real debt are affected in the same direction, making the policy-rate effect on the ratio smaller and possibly of the opposite sign. This is even more the case for the debt-to-GDP ratio (a stock divided by a flow) because then not only the price level but also real GDP enter in the denominator. The policy-rate effect on the flow of nominal GDP may be larger and quicker than the effect on the stock of nominal debt. Several recent papers have indeed found empirical support for a higher policy rate *increasing* rather than decreasing the debt-to-GDP ratio (Alpanda and Zubairy 2014; Gelain, Lansing and Natvik 2015; and Robstad 2014). Nevertheless, CB uses empirical estimates according to which the policy rate has a negative effect on both real debt and the debt-to-GDP ratio, thereby stacking the cards in favor of LAW. In spite of this, the marginal cost of LAW exceeds the marginal benefit by a substantial margin.

Bauer and Granziera (this issue) (BG for short) provide an interesting and thorough examination of the policy-rate effect on real debt and the debt-to-GDP ratio. Their measure of the debt-to-GDP ratio is the percent deviation from a two-sided Hodrick-Prescott filter. They show for the point estimates of the impulse responses in their figure 5 (which are GDP-weighted averages of the point estimates for each country) that the debt-to-GDP ratio initially increases but that it later decreases. However, they report 68 percent confidence sets rather than 90 percent. If one takes a 90 percent confidence set to be 1.65 times as wide as a 68 percent, it is apparent that the effect on the debt-to-GDP ratio is not statistically significant from zero. Furthermore, their impulse responses are sensitive to the identification assumptions used as well as to alternative specifications, as shown by the robustness tests reported in their

figure 7.[5] In particular, all alternatives (except using the target rate as the interest rate instead of a three-month rate) show medium-term responses of the debt-to-GDP ratio closer to zero than the benchmark response.

I find the impulse response for output in their figure 5, with a large immediate fall and a medium-term increase (which contributes to the medium-term fall in the debt-to-GDP ratio), quite unrealistic. I believe there is strong economical and empirical support (not to speak of practical policy experience) in favor of a U-shaped output response (and a hump-shaped unemployment response) from a policy tightening with a small or zero response in the current quarter.[6] Interestingly, for the added restriction of a zero initial impulse to output, the medium-term response of the debt-to-GDP ratio in figure 5 is closer to zero.[7]

As far as I can see, the results do not contradict that the policy-rate effects on real debt and the debt-to-GDP ratio are likely to be small and could be of either sign.[8]

BG also provide their own estimates of the effect of the debt-to-GDP ratio. By combining this with their estimates of the policy-rate effect on the debt-to-GDP ratio, they compute the policy-rate effect

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[5]The impulse responses are also apparently sensitive to using real or nominal debt instead of the debt-to-GDP ratio in the VAR. From an economic point of view, nominal debt seems to be the natural variable, given that debt is specified and displays inertia in nominal terms. See also Brunnermeier et al. (2017).

[6]The representative output impulse response underlying figures 1 and 2 has output (translated from the unemployment response with an Okun coefficient of 2) being zero in quarter 1, falling to about 1 percent below the baseline in quarter 6, and then slowly rising back to the baseline.

[7]Looking at the impulse response of the interest rate in figure 5, with the interest rate turning negative in the medium term and the inflation response being small, one might think that the implied response of the real interest rate is negative in the medium term and that the policy shock is actually expansionary in the medium term. However, the inflation is apparently quarterly inflation at a quarterly rate. If multiplied by 4 and expressed as an annual rate and deducted from the interest rate, the resulting (ex post) quarterly real rate at an annual rate is actually positive and falling to close to zero in the medium term. Then the positive medium-term response still looks strange to me.

[8]Also, with a "financial cycle" as in Drehmann, Borio, and Tsatsoranis (2012) including real debt and debt to GDP, the policy-rate effect on it is likely to be small and possibly even of the opposite sign. Consistent with this, the policy-rate impact on the "leverage gap" in Juselius et al. (2016, table 3) is small, positive, and not statistically significant.

on the probability of a crisis within the next two years. Their results are shown in their figure 9, for the debt-to-GDP ratio being initially on trend as well as, respectively, 5 and 10 percent above trend. For a systemic banking crisis, shown in panel A, consider the case for the debt-to-GDP ratio initially on trend. Then the probability of a crisis (within the next two years) is initially 6 percent. This can then be taken to be the probability of a crisis without LAW. With LAW, the probability of a crisis first rises above 6 percent to a maximum at 7.8 percent in quarter 5, then falls back to about 6 percent in quarter 9, and finally falls below 6 percent after quarter 9. (Actually, the probability of a crisis eventually falls to close to zero, which is clearly implausible and raises some doubts about the empirical results.)

Thus, the point estimate of the probability of a crisis is higher under LAW for several quarters. More importantly, the 68 percent confidence sets in figure 9 are large and growing with the horizon. The arguably more relevant 90 percent confidence sets are even larger. All movements are well within the confidence sets, and any shift is not statistically different from zero. This is consistent with the observation by some FOMC (2016) participants that "the benefits are highly uncertain."

As far as I can see, these results do not provide support for benefits from LAW that might match or dominate the costs shown in figures 1 and 2.

4.   LAW in a DSGE Model

An alternative approach to examine LAW is to introduce LAW in a DSGE model. It is of course of some interest to examine the consequences of a systematic policy of LAW, including how it might affect private-sector expectations. But such examination of a systematic policy requires a complicated DSGE model with, in practice, many assumptions and complicated parameter estimation. In particular, the mechanisms and channels through which monetary policy might affect the probability and magnitude of a crisis should ideally be included in the model, increasing the complexity of the model and of the corresponding estimation and calibration. The results will be heavily model dependent and not very robust. It is always possible to construct a model in which some LAW is optimal; the crucial and

difficult questions are how reasonable and realistic the model is and how robust the results are.

Gerdrup et al. (this issue) (GHKM for short) study the consequences of LAW in a DSGE model of Justiniano and Preston (2010), a model estimated on data from Australia, Canada, and New Zealand. The role of credit is not integrated in the model, but credit developments are modeled as a block separate from the core model. Credit only affects the probability and magnitude of a crisis and has no other effects. Importantly, the private sector does not take the possibility of a crisis into account. The effects of five-year real credit growth on the probability and magnitude of a crisis are calibrated based on a sample of OECD countries. The policy-rate effect on credit is calibrated to match the response to a monetary policy shock in the structural VAR model for Norway in Robstad (2014). A (financial) crisis is represented by a negative demand shock.

Monetary policy is assumed to follow a Taylor-type policy rule. LAW is represented by the policy rate responding to pre-crisis real credit growth when it is positive but not when it is negative. Thus, LAW is asymmetric. The authors choose the response coefficients of the policy rule to minimize the weighted sum of the unconditional variances of inflation, the output gap, and the first difference of the policy rate, that is, using as a loss function

$$W_0 = \text{Var}[\pi_t] + \lambda_y \text{Var}[y_t] + \lambda_i \text{Var}[\Delta i_t], \qquad (5)$$

where Var[ ] denotes the unconditional variance.

The authors report several results. In particular, for the given type of policy rule, a positive response coefficient on real credit growth is optimal. In that sense LAW is justified in the model. However, the amount of LAW is arguably quite modest, in the sense that the policy rate is on average only 18 basis points higher with LAW than without.

As noted above, figures 1 and 2 show marginal costs of LAW that exceed the marginal benefits by a large margin. It would be very interesting to see what the these figures look like for the authors' model, in order to better understand the authors' results, but unfortunately all information required is not provided.

For several reasons, I believe the robustness of the authors' results can be doubted. First, as noted, the results of a DSGE model

depend on a usually long list of specification choices and estimated and calibrated parameters. The more complex the model, the more of a black box it is, and the less clear it is how sensitive it is to alternative specifications and parameters. The Justiniano and Preston (2010) model has no less than forty-seven estimated and four calibrated parameters. Furthermore, the data behind the calibration come from several rather different countries, raising the issue of consistency among parameters. Given this, assessing the robustness of the results is not easy.

Second, more specifically, one obvious test of a model is how reasonable and realistic its impulse responses are. The paper's figure 3 shows that this model has the property that the policy rate has its largest effects on current output and inflation. Such impulse responses are in my mind highly unrealistic. Using realistic impulse responses is crucial to getting realistic estimates of the two costs of LAW mentioned above. In particular, a strong immediate policy-rate effect on output means that, by lowering the policy rate sufficiently, the central bank can completely neutralize the output effect of the negative demand shock from a crisis. This matters for the crucial second cost of LAW. A binding lower bound for the policy rate will restrict the response, but the role of the lower bound is disregarded in the paper (for instance, the experiment with a decline in foreign interest rates has the policy rate falling by about 10 percentage points). Instead, the policy is artificially restricted by the interest rate smoothing imposed (the term $(\Delta i_t)^2$ in the loss function below) and by the restriction to a suboptimal Taylor rule. Without these restrictions, in this model "cleaning" seems to be an effective way to manage crises. Given this, it would be more relevant and interesting to see what optimal policy in the model looks like, with and without a lower bound for the policy rate.[9]

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[9]There is a general problem with Taylor-type rules that is overlooked by many papers examining monetary policy with such rules. Taylor-type rules are normally suboptimal; they have too few arguments. Optimal policy requires responding to all relevant state variables, including shocks. Adding an argument to a suboptimal policy rule, as is common in many papers on monetary policy, means that the set of arguments better span the space of state variables and shocks. It is therefore not surprising if adding an argument, normally any argument correlated with left-out state variables, reduces the loss.

Third, there is reason to doubt that the authors use the right loss function. The authors start from the loss function

$$W_0 = E_0 \sum_{t=0}^{\infty} \beta^t [\pi_t^2 + \lambda_y y_t^2 + \lambda_i (\Delta i_t)^2]$$

and state that when β approaches unity the loss function approaches the weighted sum of unconditional variances in (5). However, the result of taking the limit is

$$W_0 = \lim_{\beta \to 1-} E_0 \sum_{t=0}^{\infty} (1 - \beta)\beta^t [\pi_t^2 + \lambda_y y_t^2 + \lambda_i (\Delta i_t)^2]$$

$$= E[\pi_t]^2 + \lambda_y E[y_t]^2 + \lambda_i E[\Delta i_t]^2 + \text{Var}[\pi_t]$$
$$+ \lambda_y \text{Var}[y_t] + \lambda_i \text{Var}[\Delta i_t], \tag{6}$$

where E[ ] denotes the unconditional mean. In order to use (5) one first has to show that the unconditional means $E[\pi_t]$ and $E[y_t]$ in (6) are zero ($E[\Delta i_t]$ is trivially zero). With an asymmetric policy rule and a private sector that disregard the possibility of a crisis, the unconditional means may not be zero. Indeed, the previous Norges Bank working paper version, Gerdrup et al. (2016, table A.5) reports that the unconditional means of inflation and the output gap are lower for an asymmetric LAW than for a symmetric LAW. Thus, the loss from the unconditional means may need to be considered.

In general, an asymmetric LAW policy with a higher policy rate implies an equilibrium with lower average inflation and a lower average policy rate. To see this, take the simplest possible LAW policy,

$$i_t = r + \pi_t + \theta(\pi_t - \pi^*) + \delta, \tag{7}$$

where r denotes the average real interest rate, π^* denotes a fixed inflation target, and $\delta > 0$ denotes a constant increase in the policy rate. Take the unconditional mean of (7),

$$E[i_t] = r + E[\pi_t] + \theta(E[\pi_t] - \pi^*) + \delta. \tag{8}$$

Assume that the Fisher equation holds, $E[i_t] = r + E[\pi_t]$; average inflation expectations are assumed to equal average inflation. Using this in (8) implies

$$E[\pi_t] = \pi^* - \frac{\delta}{\theta} < \pi^*,$$

$$\mathrm{E}[i_t] = r + \pi^* - \frac{\delta}{\theta} < r + \pi^*.$$

For $\delta > 0$, average inflation is lower than the inflation target. Furthermore, the average policy rate is correspondingly lower, not higher. Everything else equal, this makes the economy more vulnerable to a binding lower bound for the policy rate. Indeed, if LAW with a bias towards a higher policy rate is understood by the private sector and incorporated into expectations, it is like having a lower inflation target.

Fourth, the authors report that, if the crisis magnitude is exogenous, the (restricted) optimal policy is to lean *with* the wind. Thus, the policy-rate effect on the magnitude of a crisis is apparently larger and more important than the effect on the probability. This stands in stark contrast to the result in CB, where, also for the case of monetary non-neutrality and permanent debt in figure 3, the marginal benefit from a smaller magnitude of a crisis, (4), is significantly smaller than the marginal benefit from a lower probability, (3). In particular, the small policy-rate effect on the magnitude follows rather directly from the estimates of Flodén (2014) and Jordà, Schularick, and Taylor (2013), even when a rather large estimate of the policy-rate effect on the debt-to-GDP ratio is used (so as to tilt the case in favor of LAW) (CB, figure 4). The authors do not provide any explanation for their result.

Fifth, the authors assume that five-year real credit growth is the variable affecting the probability and magnitude of a crisis and they calibrate the crucial effect on the magnitude to that in Jordà, Schularick, and Taylor (2013). But the latter use credit-to-GDP growth instead of real credit growth. Importantly, the authors do not demonstrate that their results are robust to replacing real credit with credit to GDP.[10] Furthermore, the results might be sensitive to what credit variable enters the Taylor-type rule, but no corresponding robustness tests are provided. The paper now has quarterly real credit growth in the policy rule. Given that five-year real credit growth is the variable that is assumed to affect the probability of a crisis, one might think that the policy rate should respond to that variable. But the previous working paper version, Gerdrup et al. (2016,

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[10]CB (section 4.9) reports that its result are robust to using debt to GDP and five-year moving averages instead of real debt.

footnote 2), reports that the policy rate responding to five-year real credit growth leads to equilibrium indeterminacy. Gelain, Lansing, and Natvik (2015) also show that responding to the debt-to-GDP ratio or the real debt level leads to indeterminacy. There is thus reason to doubt the robustness of the policy rule used. Deriving the unrestricted optimal policy might perhaps have thrown some light on these issues.

Sixth, suppose that the probability and magnitude of a crisis depend on the effect of real debt growth, as in the paper. Suppose that monetary policy is neutral and has no effect on real debt in the long run. Then, if monetary policy manages to reduce real debt growth for some period, after that period real debt growth must eventually increase to reach the same level of real debt in the long run. Then the probability and magnitude of a crisis is shifted between periods, but the effect on the average probability and magnitude is small or zero.[11] If instead monetary policy is neutral and there is a permanent effect on real debt, the average probability and magnitude may be affected.

Indeed, the impulse response of five-year real debt growth in the paper's figure 3 shows real debt growth falling to almost -0.8 percent during quarters 8–20 and then rising back to zero, but not becoming positive. That is, there is implicit monetary non-neutrality and a permanent effect on real debt. The authors do not discuss this issue and provide no rationale for monetary non-neutrality. Any reasonable microfoundations for debt would normally imply monetary neutrality.[12]

Seventh, the paper assumes that only the central bank but not the private sector takes the possibility of a crisis into account. The previous working paper version of the paper (section 7) notes that the case for LAW is weaker if the private sector internalizes the possibility of a crisis. Given this, an information campaign, including a regular financial stability report, might increase the private sector's awareness of a crisis and be a substitute for LAW. Indeed, given the current discussion of financial stability issues and risk in the media

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[11]If the logistic function for the probability of a crisis is sufficiently non-linear and increases and decreases in the probability are finely timed, the net effect on the average probability need not be zero, but it is still likely to be small.

[12]The same consequences of monetary neutrality and non-neutrality apply if the probability and magnitude depend on the growth of the debt-to-GDP ratio.

and among policymakers, it is not obvious that the private sector would underestimate the probability of a crisis.

Eighth, all credit in the model is by assumption "bad credit" in the sense of increasing the probability and magnitude of a crisis and having no beneficial effects on the economy. A point with a DSGE model is normally to provide better microfoundations, but there are no microfoundations for credit in this model. If credit is incorporated into the model and provides some benefits, the costs of LAW would increase. For example, Alpanda and Ueberfeldt (2016) incorporate credit in their model and show that costs of LAW, taking into account that it hurts borrowers, normally exceed the benefits from a lower probability of crises.

Furthermore, when the role of credit is integrated with microfoundations in the model, the relative effectiveness of monetary policy and macroprudential policy can be assessed. For example, Korinek and Simsek (2016) show that macroprudential policies can be quite effective in dealing with excess household debt and that interest rate policies are likely to be inferior in this respect. Alpanda and Zubairy (2014) incorporate housing and household debt in a DSGE model and find that macroprudential measures to reduce household debt are more effective and less costly than monetary policy. Chen and Columba (2016) analyze the effects of macroprudential and monetary policies and their interactions in an estimated DSGE model tailored to Sweden. They find that demand-side macroprudential measures are more effective in curbing household debt ratios than monetary policy, and they are less costly in terms of foregone consumption. Indeed, when credit is introduced as in Gerdrup et al. (this issue), it is trivial that a macroprudential policy restricting credit is preferable to monetary policy (see the Svensson 2012 comments on Woodford 2012).

In summary, for several reasons mentioned, the authors' results are unlikely to be robust.

5.   A Framework for Comparison of Results

The simplicity and transparency of the CB framework—in particular, its dependence on only a few assumptions and estimates—make it a possible candidate for a comparison of different results about the costs and benefits of LAW. From (2)–(4) it follows that, for a

comparison, what is required are assumptions about or estimates of (i) the probability of a crisis in future quarters, (ii) the expected magnitude of a crisis, (iii) the expected duration of a crisis, and the policy-rate effects on (iv) unemployment or output, (v) the probability of a crisis, and (vi) the magnitude of a crisis. With these building blocks, the marginal costs of LAW and the marginal benefits from a lower probability and smaller magnitude of a crisis can be constructed and compared and robustness and sensitivity analysis conducted.

Also for approaches that examine LAW in DSGE models, it seems that it should always be possible to construct these building blocks, including impulse responses of unemployment or output and of the probability and magnitude of crises. A comparison within this framework should at least provide some information that helps in understanding and evaluating different approaches and results.
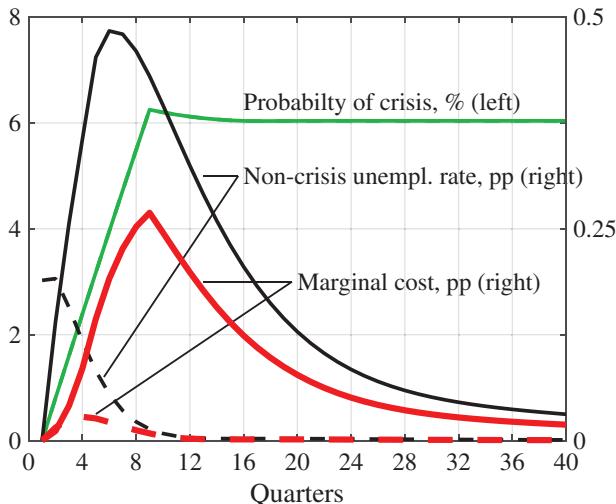
An extensive analysis of different new and old approaches and results with the use of the CB framework is left for a separate paper. Here I will just show an example for the marginal cost of LAW. Above I noted that I found the impulse responses of output to the policy rate in BG and GHKM to be highly unrealistic. Here we will see what marginal costs of LAW they imply and how these differ from the CB benchmark marginal cost.

In figure 4, the hump-shaped solid black line shows the CB benchmark policy-rate effect on (that is, the impulse response of) the unemployment rate $(d\mathrm{E}_1 u_t^{\mathrm{n}}/d\bar{\imath}_{it})$.[13] The solid green line rising from zero to above 6 percent in quarter 9 and then falling back to 6 percent shows the CB benchmark probability of (having) a crisis for each quarter (p_t). It is given by a Markov process but is approximately equal to the sum of a crisis start in the last eight quarters, under the assumptions that there is no crisis is quarter 1, that the benchmark quarterly probability of a crisis start is 0.8 percent, and that the duration of crises is eight quarters.

From (2) and the benchmark assumption that the crisis increase in the unemployment rate (Δu) is 5 percent it follows that the marginal cost is simply ten times the product of the probability of a crisis

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[13]Colors appear in the online version, but the lines are also labeled and easily identified in printed versions.

Figure 4. The Probability of a Crisis, the Policy-Rate Effect on the Non-crisis Unemployment Rate, and the Marginal Cost of LAW for Svensson (2017a) (Solid Lines) and Gerdrup et al. (2017) (Dashed Lines)
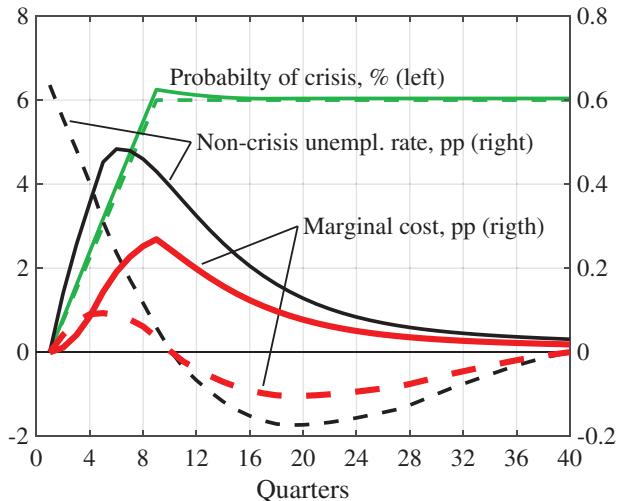

and the policy-rate effect on the unemployment rate. The hump-shaped solid red line then shows the CB benchmark marginal cost, thus calculated as ten times the product of the solid green and black lines. It is the same marginal cost as in figures 1 and 3. The area under the marginal cost is the cumulative (undiscounted) marginal cost of LAW, shown in figure 2.

The dashed black line in figure 4 shows the inferred GHKM policy-rate effect on the unemployment rate. It is inferred from the output-gap impulse response to a monetary policy shock in their figure 3 by a change of sign and division by an Okun coefficient of 2.[14] The CB benchmark probability of a crisis is assumed to apply also to GHKM. It is approximately consistent with their assumption of an annual steady-state probability of a crisis start of 3.3 percent

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[14]The policy-rate impulses in CB and GHKM are somewhat different, but a correction for this would not change the conclusions.

**Figure 5. The Probability of a Crisis, the Policy-Rate
Effect on the Non-crisis Unemployment Rate, and the
Marginal Cost of LAW for Svensson (2017a) (Solid Lines)
and Bauer and Granziera (2017) (Dashed Lines)**

and an average crisis duration of two years. The CB benchmark crisis magnitude of 5 percentage points is also used. It is approximately consistent with the unemployment increase in their figure 1.

The dashed red line shows the resulting GHKM marginal cost, calculated as ten times the product of the solid green and dashed black lines. It is dramatically different from the CB one. The fact that the policy-rate effect on the unemployment rate is quickly falling to zero while the probability of a crisis rises from zero results in the product being very small. Whereas the CB cumulative marginal cost up to quarter 40 is 3.6, the GHKM one is only 0.19. Clearly, whether or not the policy-rate effect on unemployment is hump shaped has a big impact on the marginal cost of LAW.

In figure 5, the dashed black line shows the inferred BG policy-rate effect on the unemployment rate, inferred by a change of sign and division by an Okun coefficient of 2 of the output impulse response in their figure 5. The dashed green line shows a linear approximation of the probability of a crisis, consistent with their

assumption of a steady-state probability of a crisis within eight quarters of 6 percent and thus a quarterly probability of a crisis start given by $6/8 = 0.75$ percent.

The dashed red line shows the resulting BG marginal cost. In particular, the negative policy-rate effect on unemployment after quarter 10 implies that the marginal cost is negative after quarter 10. Indeed, the cumulative marginal cost up to quarter 40 is negative, –1.3, not positive. The cumulative marginal cost is actually a cumulative marginal benefit. The importance for the marginal cost of a realistic and empirically supported policy-rate effect on the non-crisis unemployment rate is clear.

6.   Conclusions

The debate about costs and benefits of LAW is likely to continue, in spite of considerable evidence that the costs of LAW exceed the benefits by a substantial margin. New papers with different approaches and theoretical and empirical results from the old ones are likely to be written. It is advantageous if the different old and new approaches and estimates can be compared and understood in a simple and transparent framework. With only a few building blocks required, the simple and transparent framework of Svensson (2017a) is a possible candidate for such comparison and understanding of different results about the costs and benefits of LAW.

References

Adrian, T., and N. Liang. 2018. "Monetary Policy, Financial Conditions, and Financial Stability." Forthcoming in *International Journal of Central Banking*.

Ajello, A., T. Laubach, D. Lopez-Salido, and T. Nakata. 2016. "Financial Stability and Optimal Interest-Rate Policy." Finance and Economics Discussion Series No. 2016-067, Board of Governors of the Federal Reserve System.

Allen, F., C. Bean, and J. De Gregorio. 2016. "Independent Review of BIS Research: Final Report." Report. Available at www.bis.org.

Alpanda, S., and A. Ueberfeldt. 2016. "Should Monetary Policy Lean Against Housing Market Booms?" Working Paper No. 2016-19, Bank of Canada.

Alpanda, S., and S. Zubairy. 2014. "Addressing Household Indebtedness: Monetary, Fiscal or Macroprudential Policy?" Working Paper No. 2014-58, Bank of Canada.

Bank for International Settlements. 2014. *84th Annual Report.* Basel: Bank for International Settlements.

———. 2016. *86th Annual Report.* Basel: Bank for International Settlements.

Brunnermeier, M., D. Palia, K. A. Sastry, and C. A. Sims. 2017. "Feedbacks: Financial Markets and Economic Activity." Working Paper.

Chen, J., and F. Columba. 2016. "Macroprudential and Monetary Policy Interactions in a DSGE Model for Sweden." IMF Working Paper No. 16/74.

Drehmann, M., C. Borio, and K. Tsatsoranis. 2012. "Characterising the Financial Cycle: Don't Lose Sight of the Medium Term!" BIS Working Paper No. 380.

Federal Open Market Committee. 2016. "Minutes of the Federal Open Market Committee, April 26–27." Technical Report, Board of Governors of the Federal Reserve System.

Flodén, M. 2014. "Did Household Debt Matter in the Great Recession?" Supplement to blog post on Ekonomistas.se. Available at www.martinfloden.net/files/hhdebt_supplement_2014.pdf.

Gelain, P., K. J. Lansing, and G. J. Natvik. 2015. "Leaning Against the Credit Cycle." Working Paper No. 4/2015, Norges Bank.

Gerdrup, K. R., F. Hansen, T. Krogh, and J. Maih. 2016. "Leaning Against the Wind when Credit Bites Back." Working Paper No. 9/2016, Norges Bank.

International Monetary Fund. 2015. "Monetary Policy and Financial Stability." Staff Report.

Jordà, Ò., M. Schularick, and A. M. Taylor. 2013. "When Credit Bites Back." *Journal of Money, Credit and Banking* 45 (s2): 3–28.

———. 2016. "The Great Mortgaging: Housing Finance, Crises and Business Cycles." *Economic Policy* 31 (85): 107–52.

Juselius, M., C. Borio, P. Disyatat, and M. Drehmann. 2016. "Monetary Policy, the Financial Cycle and Ultra-Low Interest Rates." BIS Working Paper No. 569.

Justiniano, A., and B. Preston. 2010. "Can Structural Small Open Economy Models Account for the Influence of Foreign Disturbances?" *Journal of International Economics* 81 (1): 61–74.

Korinek, A., and A. Simsek. 2016. "Liquidity Trap and Excessive Leverage." *American Economic Review* 106 (3): 699–738.

Olsen, Ò. 2015. "Integrating Financial Stability and Monetary Policy Analysis." Speech at the London School of Economics, London, April 27.

Robstad, Ò. 2014. "House Prices, Credit and the Effect of Monetary Policy in Norway: Evidence from Structural VAR Models." Working Paper No. 5/2014, Norges Bank.

Schularick, M., and A. M. Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008." *American Economic Review* 102 (2): 1029–61.

Svensson, L. E. O. 2012. "Comment on Michael Woodford, 'Inflation Targeting and Financial Stability'." *Economic Review* (Sveriges Riksbank) 2012 (1): 33–39.

———. 2013. "'Leaning Against the Wind' Leads to a Higher (Not Lower) Household Debt-to-GDP Ratio." Working Paper, Stockholm School of Economics. Available at www.larseosvensson.se.

———. 2014. "Inflation Targeting and 'Leaning Against the Wind'." *International Journal of Central Banking* 10 (2): 103–14.

———. 2016. "Cost-Benefit Analysis of Leaning Against the Wind: Are Costs Larger Also with Less Effective Macroprudential Policy?" IMF Working Paper No. 16/3. Available at www.imf.org.

———. 2017a. "Cost-Benefit Analysis of Leaning Against the Wind." *Journal of Monetary Economics* 90 (October): 193–213. Available at www.larseosvensson.se.

———. 2017b. "How Robust Is the Result That the Cost of 'Leaning Against the Wind' Exceeds the Benefit? Response to Adrian and Liang." Working Paper (also available as CEPR Discussion Paper No. 11744), Stockholm School of Economics. Available at www.larseosvensson.se.

———. 2017c. "Leaning Against the Wind: The Role of Different Assumptions About the Costs." Working Paper, Stockholm School of Economics. Available at www.larseosvensson.se.

Sveriges Riksbank. 2013. "Financial Imbalances in the Monetary Policy Assessment." In *Monetary Policy Report July 2013*, 42–48. Stockholm: Sveriges Riksbank.

Williams, J. C. 2015. "Macroprudential Policy in a Microprudential World." Speech at the Symposium on Asian Banking and Finance, Singapore, May 28.

Woodford, M. 2012. Inflation Targeting and Financial Stability." *Economic Review* (Sveriges Riksbank) 2012 (1): 7–32.