Annex 5: VAR Analysis

Effects of balance-sheet variables and regulations on GDP growth: Reduced-form evidence

In this annex, we use a reduced-form model of real GDP and balance-sheet variables on the impact of the balance-sheet variables on real GDP, and specifically the possible impact of a regulatory increase in the capital-asset ratio on real GDP. We did this, as suggested by the MAG draft report, by estimating a vector autoregression (VAR) in real GDP, real capital and asset data, and several control variables. Since our data set is short, considerable uncertainty remains, but what we can ascertain from the VAR suggests that the effect of such a regulatory increase would be fairly small.

1. Data

We used quarterly data from 1994Q3 through 2008Q3; data on all the series are available out to 2010Q1, but we decided to follow the MAG draft report's suggestion of omitting data from the financial crisis. With only 15-odd years of data, the large shocks during the financial crisis would be given much more weight than arguably is desirable for the purpose of determining a response to a "typical" policy shock.

The main variables of interest were:

1. The rate of growth of real Canadian GDP (RGDP);
2. The rate of growth of the total regulatory capital of the six major Canadian banks, deflated with the GDP deflator (RCAPITAL); and
3. The rate of change of the ratio of total regulatory capital to the risk-weighted assets of the six major Canadian banks (CAPASSET). Note use of the ratio, not the logged ratio; while use of the logged ratio does not affect our results appreciably, using the "raw" ratio makes it slightly easier to conduct policy analysis in terms of changes in the capital/asset ratio.

We added, as control variables:

1. The rate of growth of total loans, deflated by the GDP deflator (RLOANS);
2. The quarterly rate of change of the policy rate, viz. the target for the overnight rate (OVNQ); and
3. The rate of growth of logged U.S. GDP (USRGDP), with which Canadian GDP growth is highly correlated. U.S. GDP entered into the VAR exogenously, since U.S. GDP is for all practical purposes unaffected by Canadian GDP; hence, U.S. GDP entered the VAR equations contemporaneously and at the first lag.

Since our time series are less than 60 quarters in length, degrees of freedom were at a premium. For this reason, our VARs included only one lag of each endogenous variable. We found no significant autocorrelation in the residuals of any the equations.

2. Results

The results we report below are from the most basic formulation of the reduced-form model suggested by the MAG draft report, viz. a simple unrestricted VAR, without use of error-correction terms. Use of error-correction terms does not appear to affect the overall thrust of the results. We did experiment a little with an error-correction term estimated as the residual of the capital/asset ratio from various indicators of the target, as we did in our study of the effects of regulatory changes on asset and capital growth. While the capital gap was significant in the capital-asset ratio and capital-growth equations, however, it did not seem to be significant in the GDP equation.

One fairly robust result across specifications is that the role of changes to capital-growth and capital/asset ratios in the Canadian business cycle has been fairly small, at least in the Canadian case, at least as measured by their weight in the variance of GDP. Table 1 gives a variance decomposition of GDP one year ahead assuming a standard Cholesky decomposition of shock disturbances, with GDP ordered last. (Changing the ordering does not change the results appreciably; since GDP is not very persistent, the proportions of variance from each shock do not change much after a year ahead.) Shocks to the growth rate of real bank capital can only account for a bit more than 4 per cent of the variance of GDP growth, using the data from 1994 to 2008. Adding the data from the financial crisis lifts it only to about 5 per cent. Shocks to the capital-asset ratio play an even smaller role, no more than 2 per cent.

Table 1: Variance decomposition of real GDP from balance-sheet variable VAR

Data set	Proportion of GDP variance attributable to shocks to				
	Capital/asset ratio	Capital growth	Real GDP	Loan growth	Overnight rate
Through 2008Q3	1.71	4.37	90.75	1.64	1.53
Through 2010Q1	1.38	5.09	90.79	1.57	1.16

Since the measured role of capital and capital-asset-ratio shocks is fairly small, it will come as no surprise that the measured effects on GDP of permanent shocks to the capital-asset ratio will be fairly small and imprecisely measured. We looked at the estimated cumulative effect on Canadian GDP of exogenous (presumably policy-driven) changes to the capital-asset ratio. There is no unique way to identify structural shocks in a reduced-form VAR model, and the MAG report was not clear as to how exogenous shocks to the capital-asset ratio were to be identified in the VAR. We settled on a Cholesky lower-triangular ordering with the order OVNQ-CAPASSET-RCAPITAL-RLOANS-RGDP, with the policy instruments (the policy rate and the capital-asset ratio) ordered first and affecting real capital, real loans, and real GDP contemporaneously. This helps to better allow for the obvious cross correlation between disturbances in the capital-asset ratio and capital and loan growth.

We report the point estimates for the cumulative effect on real GDP of each of the following scenarios:

    (a) The capital-asset ratio is raised by 0.25 per cent a quarter for eight quarters.
    (b) The capital-asset ratio is raised by 0.125 per cent a quarter for sixteen quarters.

Both scenarios raise the capital-asset ratio by 2 per cent over the long term.

The point estimate for the impact of the capital-asset-ratio increase under both scenarios and assumptions are given in Table 2; the four- and eight-year impact are compared with the range from the MAG interim report. The impacts on GDP are near or below the median reported in the MAG draft report, and, as reported there for other countries, uncertainty is great enough that none of these estimates is significantly different from zero.

Table 2: Estimated deviations of level GDP from baseline forecasts

Capital ratio increased by 2 percentage points	Impact on real Canadian GDP over:				MAG cross-country results		
	1 year	2 years	4 years	8 years		4 years	8 years
Over 2 years	-0.24	-0.43	-0.38	-0.38	Median	-0.6	-0.5
					Maximum	0.5	0.0
					Minimum	-1.7	-1.8
Over 4 years	-0.12	-0.22	-0.40	-0.38	Median	-0.7	-0.8
					Maximum	0.4	0.1
					Minimum	-2.4	-1.1

3. Conclusion

Depending on how exogenous (presumably policy-driven) shocks to economy-wide bank capital/asset ratios are identified, we find that a 2 per cent increase in the capital-asset ratio ordered by regulation should reduce Canadian GDP by a small amount. Our best guess for the drop in level GDP is about 0.4 per cent over four years from a 2 per cent increase, but with our limited data set, there is considerable uncertainty regarding that estimate. Underlying that uncertainty is the fact that over the period for which we have reliable data, the role of shocks from balance-sheet variables in driving movements in Canadian GDP has been quite small.