UNITED STATES

SELECTED ISSUES

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UNITED STATES

SELECTED ISSUES

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CONTENTS

RECENT US LABOR FORCE PARTICIPATION DYNAMICS: REVERSIBLE OR NOT?[1]

A. Introduction

1. **The U.S. labor force participation rate (LFPR) fell dramatically following the Great Recession and has yet to start recovering** (Figure 1). Indeed, the current LFPR of 62.8 percent is the lowest rate since 1978. Taking a longer view of LFPR dynamics yields some important background to the recent decline (Figure 2). In particular, the LFPR increased sharply from just below 60 percent in the early 60s to above 66 percent by 1990, largely reflecting the baby boom generation (especially women) entering the labor force. Over the 1990s, the trend line flattened sharply, with the LFPR reaching a global peak of 67.3 percent in 2000Q3, as participation rates for new cohorts of women stopped increasing. Since the 2001 Recession, the LFPR has been largely on a secular decline.

Figure 1. Labor Force Participation Rate
(In percent)

Participation Rate
Nov. 2007 BLS Forecast

Sources: U.S. Bureau of Labor Statistics, Haver Analytics

2. **A key question is how much of the post-2007 decline is reversible.** LFPR dynamics can be driven by structural factors (e.g. population aging, increased college enrollment as education becomes more accessible, or later retirement due to better health) and cyclical ones related to job prospects. And forecasting is complicated by the fact that some structural factors could be reversible, (e.g. if the trend of increasing college enrollment reversed because the cost of college education for the marginal student became too high relative to the return), while part of the LFPR decline associated with cyclical factors could become irreversible (e.g. if the Great Recession led to more older workers to apply, and get accepted, for

Figure 2. Labor Force Participation Rate
(In percent)
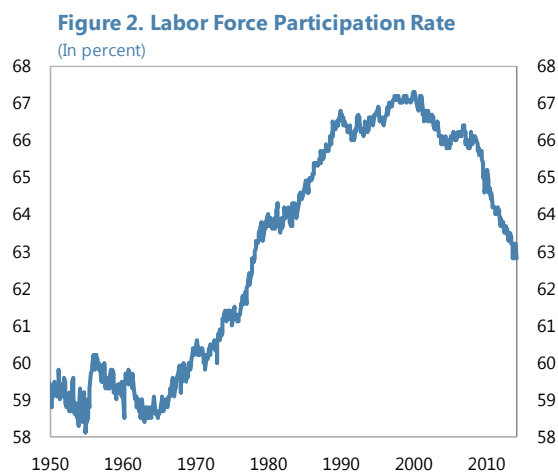
Sources: U.S. Bureau of Labor Statistics, Haver Analytics

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[1] Prepared by Ravi Balakrishnan, Mai Dao, Juan Solé, Jeremy Zook (WHD). The authors are grateful to Robert Arnold, Roberto Cardarelli, Nigel Chalk, Bruce Fallick, Andy Levin, Robert Shackleton and Mitra Toosi for helpful discussions and comments.

social security disability insurance).

3.   **Explaining the post-2007 decline is at the center of the policy debate**. This is because understanding the extent to which the decline is reversible and hence the LFPR's future path is crucial to estimating the amount of slack in the labor market. With the Federal Reserve having a mandate for maximum employment as well as price stability, the degree of labor market slack is a key factor when determining the future course of monetary policy, in particular how gradually interest rates should rise if there is a large amount of slack. The future dynamics of the LFPR are also a key driver of potential output, explaining why labor supply policies are receiving a lot of attention.

4.   **Against this background, this chapter addresses the following questions**:

- How much of the decrease since the Great Recession is driven by demographics, cyclical, and other structural forces? How much is reversible?

- What is the baseline forecast for the LFPR over the next few years? What are the risks around this baseline? What is the current and projected level of labor market slack?

- What are the macroeconomic and supply-side policy implications?

5.   **The key chapter finding is that while around ¼-⅓ of the post-2007 decline is reversible, the LFPR will continue to decline given population aging**. With participation rates for older workers lower than for prime age workers, demographic models suggest that aging of the baby boom generation explains around 50 percent of the near 3p.p. LFPR decline during 2007-13. State-level panel regression analysis is used to tie down the cyclical effect, which is estimated to account for about 30-40 percent of the decline. The rest is made up of non-demographic structural factors such as increasing college enrollment and fewer students working. With some of the decline triggered by cyclical factors and non-demographic structural factors judged to be irreversible, only around a ¼-⅓ of the post-2007 decline is forecast to be reversed over the next few years as job prospects improve. And as population aging continues to weigh, this reversal only causes the LFPR to flatline in the near term projection, with the secular decline reasserting itself once the cyclical bounceback starts to wane.

6.   **Significant remaining slack in the labor market points to an important role for macroeconomic and labor supply policies**. The chapter's measure of the "employment gap", suggests that labor market slack is still high and will only decline gradually in the baseline scenario. This suggests a still important role for stimulative macro-economic policies to help reach full employment. In addition, given the continued downward pressure on the LFPR, labor supply measures will be an essential component of the strategy to boost potential growth. Finally, stimulative macroeconomic and labor supply policies should also help reduce the scope for further hysteresis effects to develop (e.g., loss of skills, discouragement).

7.   **The rest of the chapter is organized as follows**. Section B estimates the structural decline in the LFPR that can be explained by population aging ("the demographic effect") using national

level analysis by different age groups. Section C uncovers the cyclical component of the recent decline in the LFPR by using state-level panel regression analysis. Section D discusses some key demographic and economic groups affecting recent LFPR dynamics, namely youths, social security disability insurance (SSDI) recipients, and older workers. Section E presents forecasts of the LFPR over the forecast horizon and proposes a broad measure of labor market slack. Section F concludes and discusses policy implications.

B.   Population Aging and the "Demographic Effect"

8.   **Aging is starting to weigh on participation rates for both males and females, although there are some differences across genders**. Participation rates for males were already on a downward trend starting the mid 1990s (Figure 3), although their rate of decline accelerated markedly in the aftermath of the Great Recession. In particular, the participation rate of males declined by 0.1 percentage points (p.p.) per year between 1995 and 2007, compared to 0.6 p.p. per year between 2008 and 2013. Female participation rates, however, only started declining in the late 1990s, after which they have followed a similar pattern to those for males. The recent pattern of downward pressure on participation rates for both men and women is consistent with population aging (Figure 4).

Figure 3. Labor Force Participation Rates
(in percent)
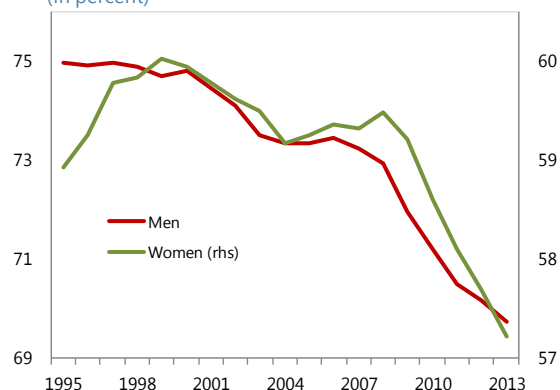
Sources: U.S. Bureau of Labor Statistics, Haver Analytics

Figure 4. Population Shares
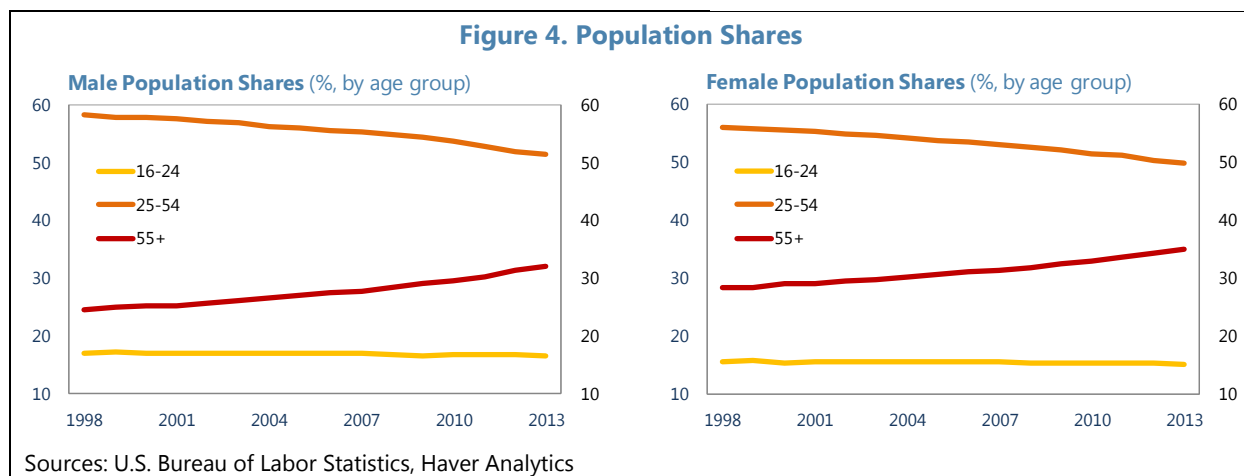
Sources: U.S. Bureau of Labor Statistics, Haver Analytics

9.   **Older workers have increased their participation rates, whereas youths and prime-age workers have reduced them**. 16-24 year-olds have been steadily reducing their participation rates since 2000. Similarly, although to a lesser extent, prime-aged workers have also reduced their participation rates (Figure 5). Older workers, however, have increased their attachment to the labor force: most notably those aged 65 and above, for whom participation rates have increased by almost 50 percent for males and nearly doubled for females since the late 1990s.

10.   **To estimate the total demographic effect of these changes, population models and "shift share" analysis are used**. Both approaches utilize detailed census and BLS data on population and labor force by age group and gender. Below we present the results of the shift share analysis, but the population models (which estimate the "demographic effect" by holding the participation rate of each age group constant at 2007 levels) deliver similar results, and are discussed in Annex 1 along with a more detailed description of the methodology and robustness checks.

Figure 5. Participation Rates

Sources: U.S. Bureau of Labor Statistics, Haver Analytics
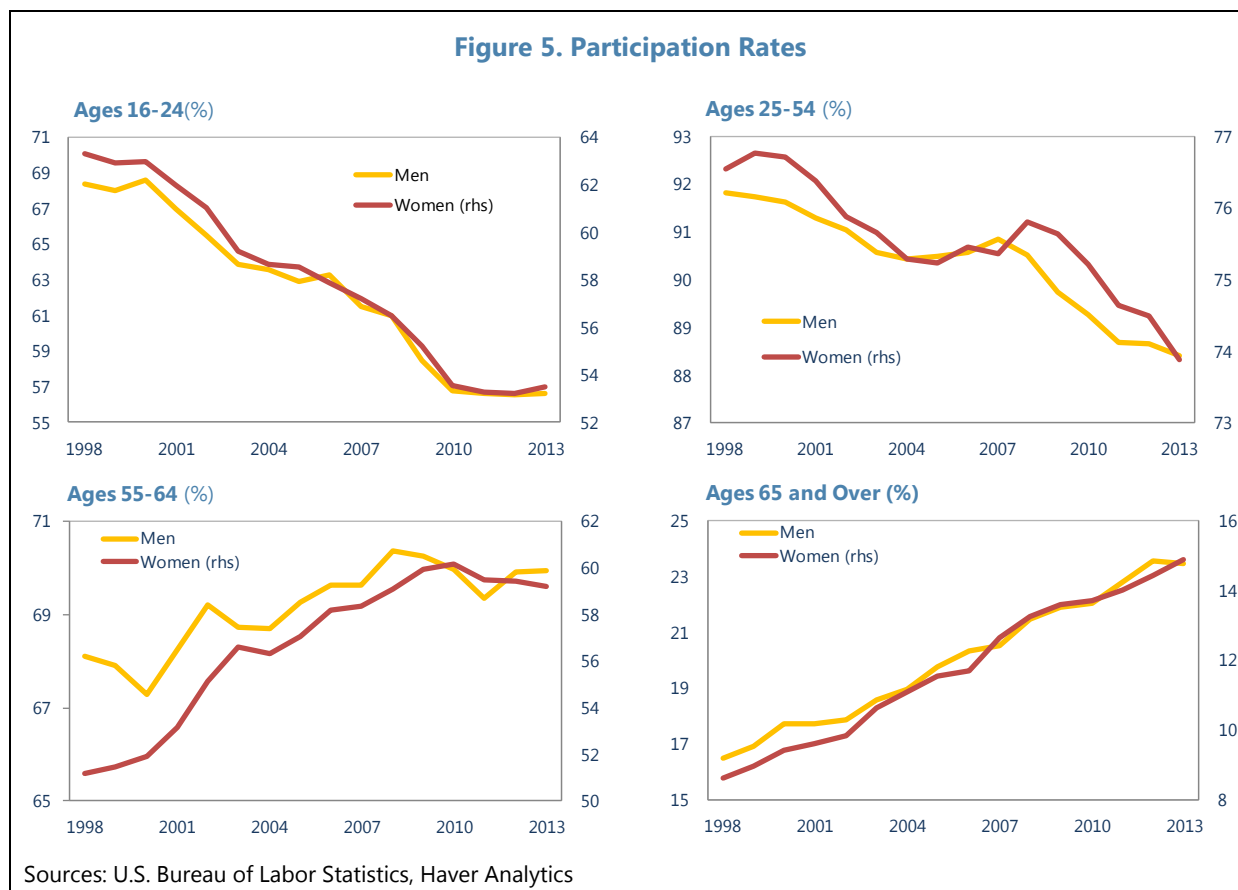
11.   **Shift share analysis quantifies the relative importance of changes in the population shares and participation rates of each age group**.[2] The total change in the participation rate with respect to a base year can be approximated as the sum of (a) changes in the population share of each group weighted by their base-year participation rate (the so-called population share shift or "demographic effect"); and (b) changes in the participation rate of each group weighted by their base-year population share (the so-called participation rate shift):

$$(1) \quad p_t - p_0 \approx \Sigma_g \{ p_0^g (s_t^g - s_0^g) + s_0^g (p_t^g - p_0^g) \},$$

---

[2] The decomposition uses data on population and labor force from the Household Employment Survey (*cf.* Annex I for more details).

where p_t stands for the aggregate participation rate, and p_t^g and s_t^g stand for the participation rate and the population share of age group *g* in year *t*, respectively.

12.   **The population shift ("demographic effect") explains around 50 percent of the drop in the aggregate participation rate during 2007-2013, but this masks important differences by gender and age group** (Tables 1-2). During 2007-10, the decline in male participation is largely explained by falling participation rates rather than the effects of aging, whereas during 2010-13 population aging is the main driver. For women, the decline in the LFPR was much smaller during 2007-10 and, interestingly, declining participation rates were more important than aging during 2010-13. Decomposing by age group, for males, both the young (16-24) and middle-aged (25-54) left the labor force in 2007-10, whereas during 2010-13 mostly the latter dropped out. For women, the young abandoned the labor force in 2007-10, whereas during 2010-13 middle aged and older workers started leaving.

Table 1. Shift Share Analysis: Deviations from Base Year

Total Population	Total LFPR Change	Population Shift	Participation Shift
2007-10	-1.3	-0.6	-0.8
2010-13	-1.5	-0.8	-0.7
Men			
2007-10	-2.0	-0.6	-1.5
2010-13	-1.5	-1.0	-0.4
Women			
2007-10	-0.7	-0.5	-0.2
2010-13	-1.4	-0.6	-0.8

Sources: U.S. Bureau of Labor Statistics, Haver Analytics and IMF staff calculations
Note: The total LFPR change equals the sum of the population shift, the participation shift, and the interaction term (cf. Annex I).

Table 2. Shift Share Analysis: Deviations from Base Year

	Men		Women	
	2007-10	2010-13	2007-10	2010-13
Total LFPR Change	-2.0	-1.5	-0.7	-1.4
Pop. Shift 16-24	-0.1	0.0	0.0	0.0
Pop. Shift 25-54	-1.4	-2.1	-1.2	-1.3
Pop. Shift 55-64	0.7	0.6	0.6	0.5
Pop. Shift 65+	0.2	0.4	0.1	0.3
Part. Shift 16-24	-0.9	-0.1	-0.6	-0.1
Part. Shift 25-54	-0.9	-0.5	-0.1	-0.7
Part. Shift 55-64	0.1	0.0	0.3	-0.2
Part. Shift 65+	0.2	0.1	0.1	0.1

Sources: U.S. Bureau of Labor Statistics, Haver Analytics and IMF staff calculations
Note: The total LFPR change equals the sum of the population shift, the participation shift, and the interaction term (cf. Annex I).

C. Estimating the "Cyclical Effect" Using State Level Data

13.   **To uncover the cyclical effect on the participation rate, we exploit the variation across states**. Essentially, this section is focused on what share of the participation rate shift identified in Tables 1-2 can be attributed to cyclical factors, while Section D looks at the share related to structural factors other than the demographic effect.

Panel Regression Analysis Across States

14.   **To uncover the cyclical effect on the participation rate, we use an instrumental variable approach to identify state-specific business cycles**. The basic model pools the data across states into a panel regression as follows:

(2)

$$\Delta PR_{st} = \delta_{1s} + \delta_{2s} * trend_t + \sum_{k=0}^{l} \beta_k * \Delta cycle_{s,t-k} + \xi_{st}$$

The constant and time trend are allowed to be state specific, reflecting state-specific linear and quadratic trends in levels of the LFPR, and hence capture differences in demographic and other structural trends across states. We measure state labor demand or the cyclical position using measures of the employment gap at the state level. To take account of short-term shocks to labor supply (e.g. reactions to policy such as unemployment insurance benefit extensions or temporary tax changes) and other sources of endogeneity, equation (2) is estimated by both OLS and 2SLS, where the employment gap is instrumented by a measure of predicted employment growth based on each state's industry mix (see Annex II for details).

Figure 6. State Changes in LFPRs and Unemployment Rates (2007-2012)

Sources: U.S. Bureau of Labor Statistics, Haver Analytics
Note: States are ordered by the magnitude of change in the Labor Force Participation Rate.
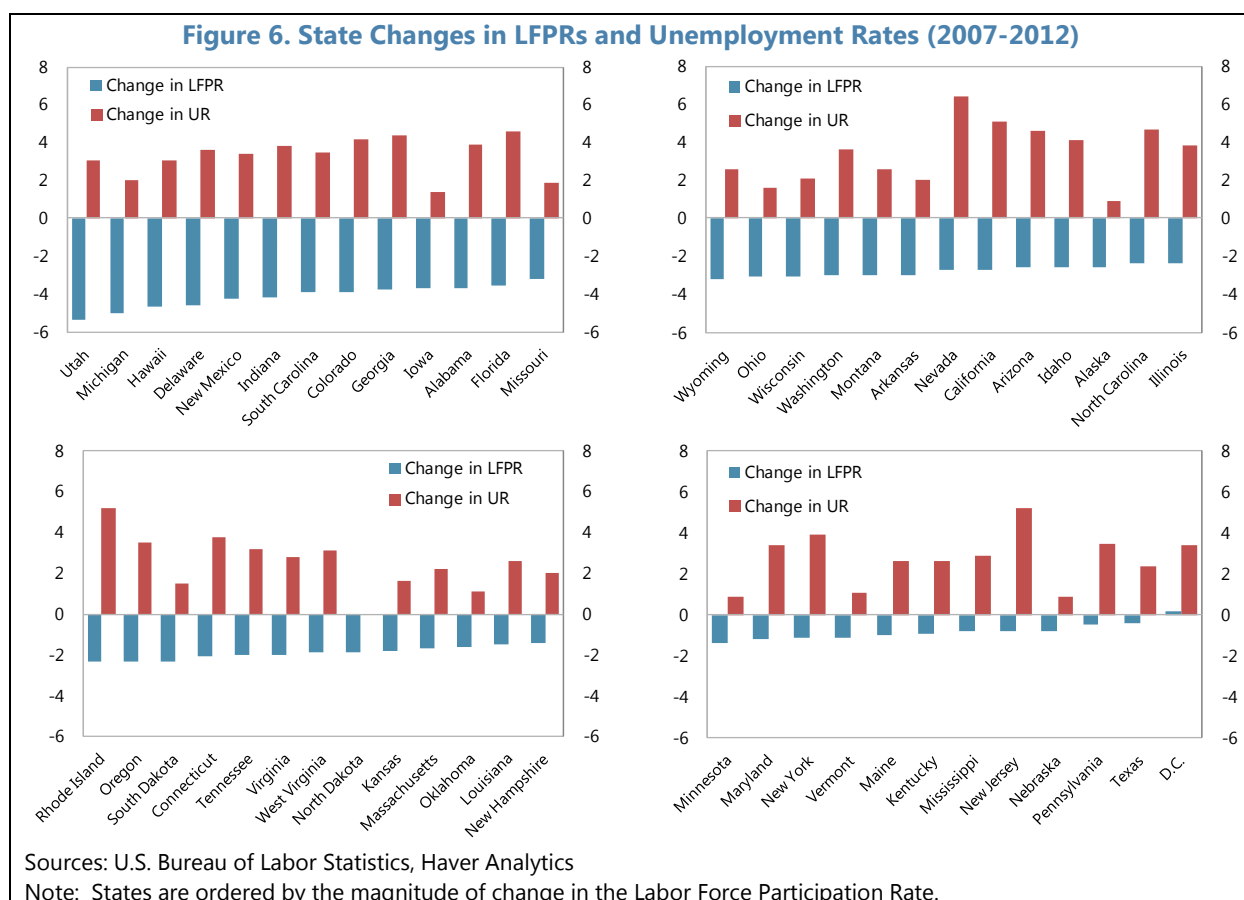
15.   **The importance of taking account of endogeneity is evidenced by the lack of a clear relationship between state unemployment and participation rates since the Great Recession** (Figure 6). The unemployment rate is often thought of as a good measure of cyclical slack. Hence, the relationship between the change in the unemployment rate and the change in the participation rate should illustrate how job prospects influence the decision to participate in the labor force. Strikingly, the participation rate change is only weakly correlated with the unemployment rate change (correlation coefficient of -0.16). For example, New Jersey and California experienced

roughly the same increase in unemployment rate. Yet, the fall in participation rate in California was almost three times larger than in New Jersey. The participation rate fell by 2 p.p. in North Dakota and Virginia but relative to 2007, the unemployment rate was 2.8 p.p. higher in Virginia in 2012 but unchanged in North Dakota. The weak correlation could be the result of either: i) the unemployment rate not being a good proxy for cyclical slack, or ii) the participation rate being driven by other forces apart from cyclical ones, or both.

16.   **A significant cyclical effect is estimated, with some important lags of adjustment**. Table 3 summarizes the regression results using the payroll employment gap as independent variable for the period 1976-2012. Similar results using state-level household employment are given in Annex II. The lower half of the table shows that the first stage coefficient is large, positive, and statistically significant (with very high F-statistics), making the industry mix variable a strong and appropriate IV for state-level labor demand. The 2SLS estimate is larger than with OLS, and the difference is statistically significant as implied by the p-value of the Hausman test.[3] They imply that a 1 percent increase in the employment gap leads to a 0.1 percentage point increase in participation rate in the same year, and another 0.1 percentage point increase in the subsequent two years. Weighting the states by their average population does not change the results substantially, suggesting that the average effect is not driven by peculiarities in some small or large states. While the estimates are relatively stable in the years prior to the crisis (not shown here), the dynamics during the Great Recession and recovery differ: the contemporaneous cyclical effect on the participation rate is reduced by half, and the adjustment is more persistent. The total effect of a 1 percent higher employment gap is still around 0.2 p.p., but distributed roughly evenly across 4 years.

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[3] The endogeneity is much more evident in the difference between OLS and 2SLS using household employment (see Table A2 in Annex II). This is not surprising, household employment, comes from the household survey and encompasses self-employment, which is more responsive to labor supply variation than payroll employment.

Table 3. State Level Regression Results

	OLS	2SLS				
				Dependent variable: Δpr_t		
		with lags	pop. weighted	1978-2007	2007-2012	
$\Delta egap_t$	0.08***	0.11***	0.11***	0.11***	0.14***	0.07**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
$\Delta egap_{t-1}$			0.03***	0.03***	0.02	0.07***
			(0.01)	(0.01)	(0.01)	(0.02)
$\Delta egap_{t-2}$			0.04***	0.06***	0.06***	0.05***
			(0.01)	(0.01)	(0.02)	(0.01)
$\Delta egap_{t-3}$						0.05***
						(0.02)
Hausman test (p-val.)		0.000	0.004	0.004	0.005	0.925
1st stage:			Dependent variable: $\Delta egap_t$			
$imix_t$		0.76***	0.73***	0.77***	0.70***	0.91***
		(0.02)	(0.02)	(0.03)	(0.03)	(0.05)
F-stat.		1432.8	985.5	841.7	668.5	413.1
N	1785	1734	1632	1632	1428	306
R^2	0.241	0.241	0.227	0.255	0.167	0.346

Sources: IMF staff calculations

Note: Column 1 estimates equation (2) with OLS and no lags in the employment gap variable. Column 2 instruments the contemporaneous employment gap with the industry mix based employment growth in equation (3). Columns 3 to 6 introduce further lags in the employment gap variable. Columns 4 to 6 weight the data by the average working-age population in each state. Column 5 and 6 splits the sample to sub-samples before and following the Great Recession. The Hausman test result reports the p-value of the null hypothesis that the contemporaneous employment gap is exogenous. The 1st stage panel reports the first stage coefficient for the contemporaneous employment gap and the first stage F-statistics. All specifications also include state-specific intercepts and trends (not shown). Standard errors are robust to heteroskedasticity and auto-correlation (using Newey-West kernel). ***, ** denote 1 and 5 percent statistical significance respectively.

Table 4. Decomposition of Aggregate LFPR Change Based on Regression Estimates

Period	Total Change in LFPR	Model using:	Cyclical Contribution		Structural + Residual	
			in ppt	in percent of total	in ppt	ppt per year
2000-2013	-3.8		-0.8 ～ -1.2	21% ～ 32%	-2.6 ～ -3.0	-0.2
2000-2007	-1.0		0 ～ 0.1	-13% ～ 0%	-1 ～ -1.1	-0.1 ～ -0.2
2007-2013	-2.9		-0.9 ～ -1.2	33% ～ 44%	-1.7 ～ -2.0	-0.3
2007-2010	-1.4	payroll emp	-0.7	53%	-0.6	-0.2
		household emp	-0.7	49%	-0.7	-0.2
2010-2013	-1.5	payroll emp	-0.5	35%	-0.9	-0.3
		household emp	-0.3	20%	-1.1	-0.4

Sources: IMF staff calculations

17.   **Recasting the regression results to decompose the actual change in the aggregate LFPR gives a cyclical effect of 33-43 percent of the near 3 p.p. drop during 2007-13** (Table 4). Using the model from the last column of Table 3, owing to the size of the shock, cyclical conditions explain about 50 percent of the 1.4 p.p. drop in LFPR during the Great Recession. Post 2010, cyclical conditions still explain 20-35 percent of the LFPR decline. The latter reflects delayed adjustment as seen in the lag structure of the estimated regression model.

Figure 7. State Changes in LFPRs: Actual vs. Predicted (2007-2012)

Sources: U.S. Bureau of Labor Statistics, Haver Analytics and IMF staff calculations
Note: States are ordered by the magnitude of change in the Labor Force Participation Rate. Predictions are based on the state-level model using the payroll employment gap (instrumented).
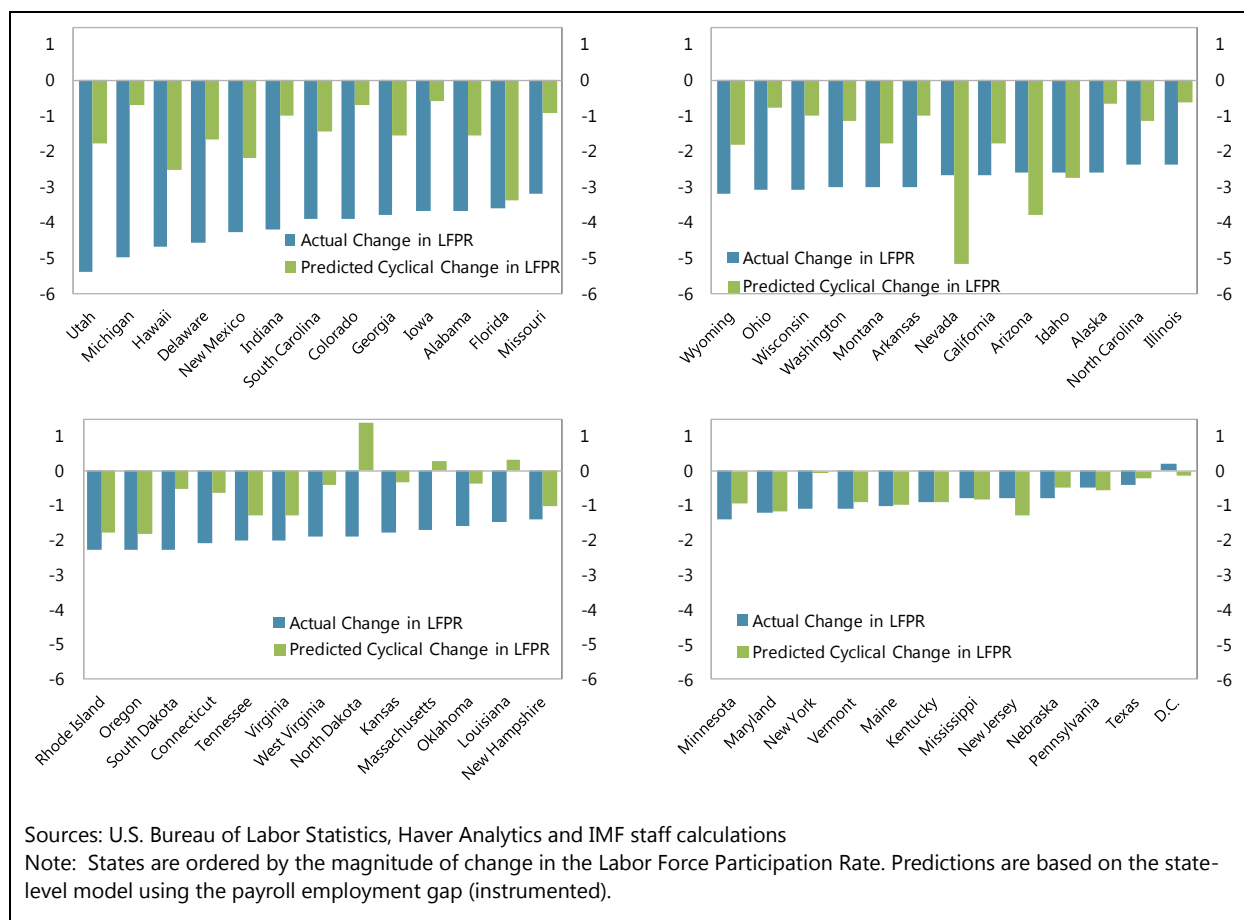
18.   **The cyclical effect can explain a significant amount of the drop in the LFPR for certain individual states, although there is substantial heterogeneity.** Using the regression results for the average response of the participation rate to cyclical forces (Table 4, column 6), we can predict the cyclical change in state-level participation based on each state's change in its employment gap since the onset of the Great Recession (Figure 7). Overall, the predicted cyclical change in LFPR is correlated with the change in unemployment across states, although not perfectly (correlation coefficient -0.6). Thus the low correlation between changes in the unemployment rate and the LFPR shown in Figure 6 suggests that the unemployment rate by itself is not a good measure of labor market slack, particularly during and after the Great Recession (as it is endogenous to changes in LFPR itself). The model predicts much of the drop in LFPR in states that were hardest hit by the crisis, notably Nevada, Arizona, Florida, and California. It also correctly predicts either no change or even a rise in LFPR in states that were least affected by the crisis: DC, New York, and especially North Dakota.

19.   **In most cases, the model predicts a smaller fall in LFPR than actually occurred, consistent with demographic and other structural forces additionally impacting the LFPR**. In a few cases, most notably Nevada and Arizona, the model actually over-predicts the decline in LFPR. A detailed look at the data shows that in these two states, the decline in LFPR was dampened by an increase in participation among the older age groups (55 years and above). This could be a response

to the housing bust and the associated loss in wealth for people in or close to retirement, who may have had to return or prolong their stay in the labor market.

Cyclical Effect by Age Group

20. **The impact of the cycle on participation generally declines with age** (Figure 8).[4] The youngest groups (teenagers and youth in their early 20s) are by far the most sensitive to cyclical conditions. Cyclical sensitivity declines as participants mature into prime working age (25-54) and become more attached to the labor force. During the crisis and recovery (right chart), the cyclicality actually decreased for young and prime-age groups (a result consistent with other findings in the literature, e.g., Shimer (2011) and Elsby et al. (2013)).[5]

21. **For older age groups, the cyclical sensitivity coefficients are volatile**. The right hand chart in Figure 8 shows that their sensitivity to the cycle varies between normal years and crisis

Figure 8. Unites States: Cyclicality of participation rate by age groups, 1999-2012
(coefficient estimate of age-specific UR on LFPR, instrumented)

Sources: IMF staff calculations
*/ Statistically significant at the 5 percent level.
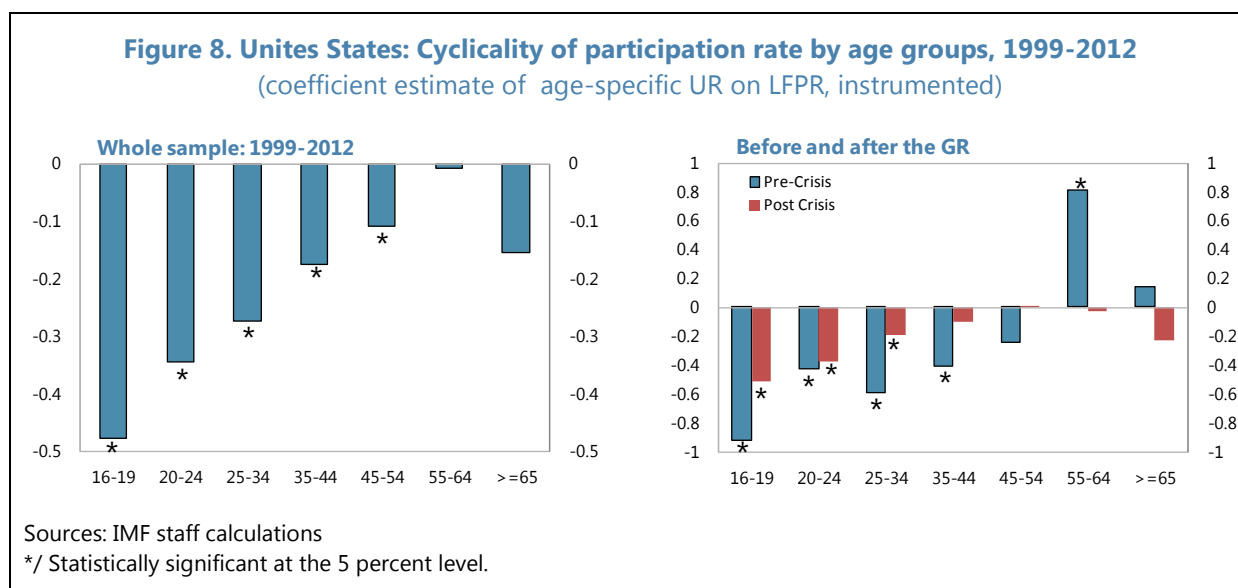
years. The group close to retirement age (54-64) had a counter-cyclical participation pattern before the crisis, likely because a strong economy translates into increasing housing and financial wealth and hence facilitates earlier retirement. However, post-2007, this effect becomes insignificant, possibly driven by heterogeneity between older workers in hard-hit states that had to increase participation (such as Nevada and Arizona) and those in less affected states who withdrew from the labor market due to poor job-finding prospects.

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[4] Due to data availability by age groups, this section relies on the 'unemployment rate' model instead of the 'employment gap' model discussed above. We still instrument to avoid endogeneity.

[5] These authors show that during recessions, the unemployment pool is composed relatively more of workers of higher skill and wages compared to normal times (as a big shock hits workers of all ranks). As these workers also have stronger labor market attachment, the average rate of transitioning into non-participation declines during recessions.

D. Youths, SSDI, and Older Workers

22.   **Participation rate trends for youths and older workers and the impact of rising SSDI recipients are key components of the aggregate LFPR picture**. However, disentangling how much of their respective changes since 2007 is cyclical, structural, or reversible is a complex issue. This section explores potential explanatory factors behind the behavior of these groups.

Youths

23.   **The majority of the reduction in youth participation rates is explained by the decline in those working while studying**. Total school enrollment has risen quite significantly since 2000, driven by increasing enrollment of 18-24 year olds in college rather than 16-18 year olds in high school (Table 5). Even more striking has been the drop of those in school (high school or college) who are working; a decline that started before the Great Recession. Indeed by 2007, the share of those working while in school had declined from a peak of 46 percent in 2000 to less than 40 percent. A similar shift share analysis to that conducted in section B suggests that this latter trend rather than rising college enrollment has been driving most of the decline in the overall youth participation rate since 2000, including during and after the Great Recession (Table 6). Some of this likely reflects a lower employment share for teenagers (and a higher employment share of older workers and immigrants) within all industries and occupations (Dennett and Modestino, 2013), possibly due to higher skill and less flexible work-time requirements, or more stringent regulation.

<table>
<tr><td colspan="7">**Table 5. School Enrollment Statistics**
(Ages 16-24)</td></tr>
<tr><td></td><td>School Enrollement</td><td>Enrolled in HS</td><td>Enrolled in College</td><td colspan="2">Enrolled in High School</td><td colspan="2">Enrolled in College</td></tr>
<tr><td></td><td colspan="3">(percent of CNIP ages 16-24)</td><td>Employed Full-Time</td><td>Employed Part-Time</td><td>Employed Full-Time</td><td>Employed Part-Time</td></tr>
<tr><td>Average 2000-2007</td><td>55.5</td><td>26.3</td><td>29.2</td><td>2.4</td><td>25.3</td><td>17.5</td><td>35.6</td></tr>
<tr><td>Average 2007-2010</td><td>57.6</td><td>25.5</td><td>32.1</td><td>1.4</td><td>17.3</td><td>14.4</td><td>33.3</td></tr>
<tr><td>Average 2010-2013</td><td>57.9</td><td>25.1</td><td>32.8</td><td>1.0</td><td>14.5</td><td>13.0</td><td>32.1</td></tr>
<tr><td>Average 2007-2013</td><td>57.8</td><td>25.3</td><td>32.4</td><td>1.2</td><td>15.9</td><td>13.7</td><td>32.7</td></tr>
<tr><td colspan="8">Sources: U.S. Bureau of Labor Statistics, Haver Analytics
1/ CNIP: Civilian Non-Institutional Population</td></tr>
</table>

Table 6. Compositional Changes in Participation by School Enrollment
(Ages 16-24, annualized changes)

Period	Part. Rate Change	Enrolled Part. Rate Shift	Enrolled Population Shift	Unenrolled Partipcation Rate Shift	Unenrolled Population Shift
2000-2007 (8)	-0.7	-0.5	0.1	-0.1	-0.2
2007-2010 (3)	-1.2	-0.8	0.2	-0.2	-0.5
2010-2013 (3)	-0.3	-0.3	-0.2	-0.2	0.4
2007-2013 (6)	-0.8	-0.5	0.0	-0.2	-0.1

Sources: U.S. Bureau of Labor Statistics, Haver Analytics
Note: First column shows the total annualized change in LFPR; subsequent columns show the contribution of different factors based on the shift-share analysis.

24.   **There appears to be a mix of cyclical and structural factors behind the decline for youths, with much of the cyclical part likely to be reversible**. It is expected that most students will join the labor force upon graduation. And while there clearly was a downward trend in the share of student workers before 2007, this share plummeted by nearly 5 p.p. in 2008-09, and has not recovered since. This suggests a sizable impact of the Great Recession and one that should be partly reversible as job prospects improve. In addition, after a secular increase since 2000, the share of students enrolled in college started to fall in 2012 (Figure 9). With the share in 2013 still 2 p.p. above that in 2007, this suggests an upside risk to youth participation rates if more students start working part time as the job market picks up and if college enrollment rates revert to pre-Great Recession levels (in part to help pay off student loans).[6]

Figure 9. College Enrollment
(In percent of population 16-24)
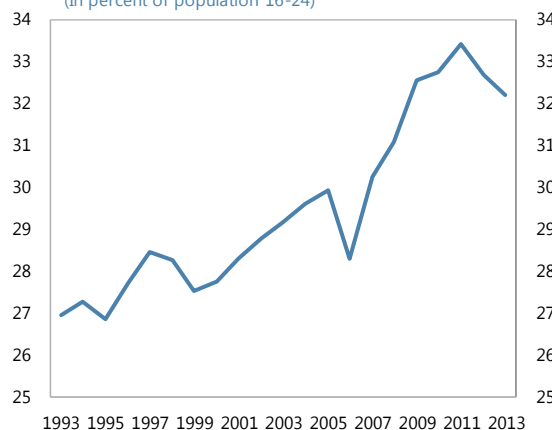
Sources: U.S. Bureau of Labor Statistics

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[6] Indeed, reverting to pre-Great Recession average levels of school enrollment and employment rates for students would increase the youth participation rate by around 7pp from the current level of 54¾ percent.

SSDI

25.   Rising SSDI beneficiaries have weighed on participation for a while. The role of SSDI has been the subject of much academic debate (e.g. Autor 2011), which is unsurprising given the relentless rise in applications since early 2000s (Figure 10). These did spike up further during the Great Recession, but this was somewhat offset by the acceptance rate declining to a near historical low. Overall, when normalized by population size, the changes in SSDI recipients didn't shift significantly following the Great Recession (Table 7), and there doesn't seem to be a strong correlation between state-level changes in SSDI recipients and LFPRs (Figure 11). Notwithstanding these findings, the rising number of beneficiaries as well as applicants that were denied benefits have undoubtedly added downward pressure on the LFPR (the change in SSDI beneficiaries/population was 0.6p.p. during 2007-13).[7]

26.   While it is open to debate how much of the recent rise in SSDI recipients is structural or cyclical, most of it will be irreversible. SSDI recipients were rising sharply as a share of the population even before 2007. Given that the incidence of SSDI increases significantly with age (nearly 80 percent of SSDI recipients are above 45 years old), much of the rise appears related to population aging (Figure 12).

27.   This is also consistent with the lack of a shift in the trend change in SSDI recipients following the Great Recession, as documented in Table 7. This would suggest that much of the increase in *recipients* is structural. However, there does appear to be a cyclical component to the spike in *applications* during the Great Recession. Regardless of how much of the rise is structural or

Figure 10. Social Security Disability Insurance
(In percent)
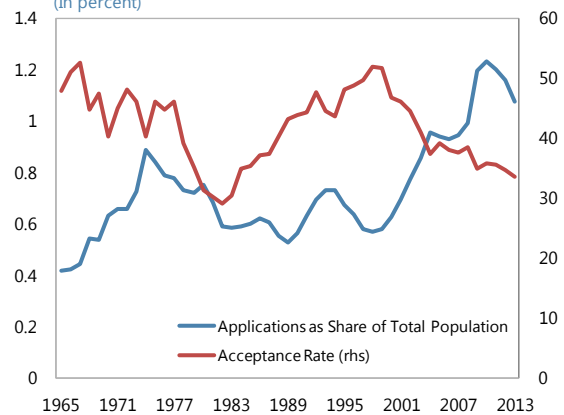
Sources: Social Security Administration

Figure 11. State SSDI and LFPR
(In percent of total population; 2007-2012)
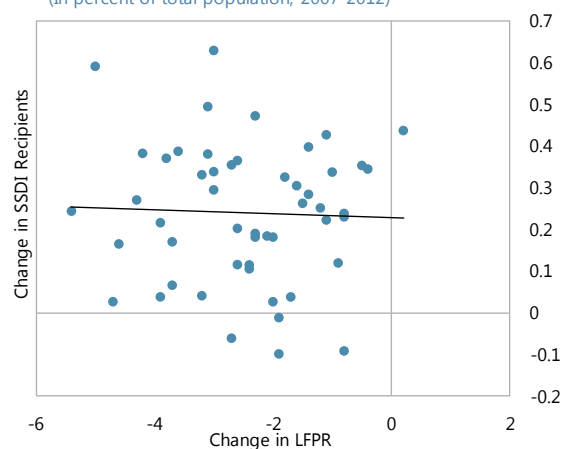
Sources: Social Security Administration, U.S. Bureau of Labor Statistics, Haver Analytics

Figure 12. SSDI Recipients and Population over 45
(In percent of total population)
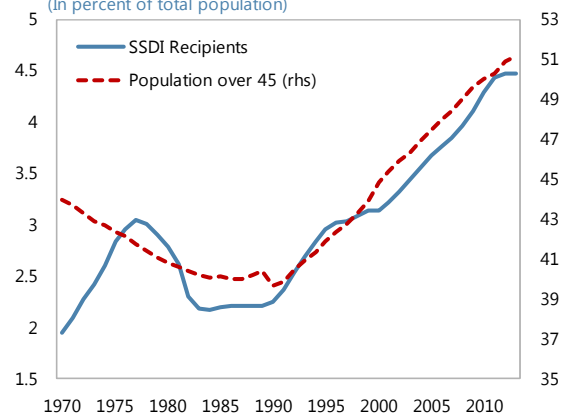
Sources: Social Security Administration, U.S. Bureau of Labor Statistics

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[7] Even those denied benefits can often spend one to three years out of the labor force until the appeals process is exhausted.

cyclical, SSDI recipients tend to exit the labor force permanently and do not return as cyclical conditions improve (Daly, Hobijn, and Kwok 2010).

	Ages 45-49		Ages 50-54		Ages 55-59		Ages 60 and above		Ages 45+
Period	SSDI Recipients	Labor Force	SSDI Recipients	Labor Force	SSDI Recipients	Labor Force	SSDI Recipients	Labor Force	Percent of Total SSDI Recipients
2000-2007 (8)	0.2	1.4	0.3	2.0	0.5	3.6	0.3	1.2	74.3
2007-2010 (3)	0.1	-0.7	0.4	1.1	0.5	1.9	0.3	1.6	78.2
2010-2012 (3)	-0.1	-2.3	0.2	0.2	0.6	1.9	0.3	1.5	79.1
2007-2012 (6)	0.1	-1.3	0.3	0.8	0.6	1.9	0.3	1.5	78.5
2013		-2.4		-0.4		1.4		0.8	

Table 7. Changes in Social Security Disability Insurance and Labor Force by Age
(Annualized changes, percent of population)

Sources: Social Security Administration; Bureau of Labor Statistics; and Haver Analytics

Older Workers

28.   **After a significant increase over the last twenty years, the future trajectory of the LFPR for older workers is an open question**. Up until early 2009, the LFPR for workers above 55 was on a steep incline, increasing by around 10 p.p. from the mid-1990s (Figure 13). Since early 2009, the rate of increase slowed significantly and the LFPR started to decline in early 2013. It now stands at around 40 percent. Some of the key factors behind the increase in the LFPR until very recently include: (i) better health and longer life-spans; (ii) stronger incentives to prolong work lives given the growing switch from defined benefit to defined contribution pension plans; and (iii) the rapid

Figure 13. LFPR of Population 55 and Over
(In percent)

Sources: U.S. Bureau of Labor Statistics, Haver Analytics

increase in healthcare costs and decreasing availability of retiree health benefits causing people to work to receive health insurance until they are eligible for Medicare (at 65). At the same time, some studies show an increasing sensitivity since 2000 of older workers' retirement decision to stock market performance (Daly, Hobijn, and Kwok 2009), which appears consistent with recent dynamics and the results shown in Figure 8. During the Great Recession, older workers stayed in the labor force given the need to rebuild net worth. Once this had been sufficiently replenished, they could afford to retire, as many have done since 2013.

E.   LFPR Forecasts and Slack Measures

LFPR Forecasts

29.   **The preceding analysis suggests that while much of the post-2007 decline in the LFPR is irreversible, there should be a material cyclical bounceback over the next few years**. Demographic models suggest that aging of the baby boom generation explains around 50 percent of the near 3p.p. LFPR decline during 2007-13, while the state-level panel regressions suggest a

cyclical effect of 33-43 percent. The demographic effect is considered irreversible and even some of the cyclical effect could be irreversible if it has led to more SSDI applications and ultimately recipients. As noted in section D, there has also been a complex interaction between cyclical and structural factors affecting youths and older workers. For youths, some cyclical bounceback is likely as job prospects improve, but for older workers, the incentive to retire as wealth is re-accumulated may offset any cyclical bounceback.

30.   **The state-level panel regression model points to a cyclical bounceback of around ¼-⅓ over the next 5 years but the LFPR continues to decline.** Equation 2 can be combined with

forecasts of the employment gap to produce a projection of the cyclical bounceback. The forecasts of the employment gap utilize staff's GDP forecasts and an employment version of Okun's Law. Table 8 gives a range of estimates depending on which version of equation 2 is used, suggesting a cyclical bounceback of ¼ - ⅓ of the LFPR decline during 2007-13.

Table 8. LFPR Bounceback

Underlying data:		Closing the labor demand gap in the MT would increase LFPR by (in ppt):	99 pct confidence interval (bootstrapped)
Payroll emp	whole sample	0.8	0.6-1.0
	07-12 sample	0.9	0.7-1.2
Household emp	whole sample	0.7	0.5-0.9
	07-12 sample	0.7	0.4-1.0

Sources: IMF staff calculations

Figure 14 shows the actual LFPR forecast and confidence bands (i.e. taking into account the structural and cyclical effects and the lag structure) from using the payroll employment version of equation 2 and the full sample. Despite the cyclical bounceback, the state-level panel regression suggests that the LFPR will continue declining as structural forces will more than offset the cyclical ones. The confidence bands reflect the sampling uncertainty around the coefficient estimates of the underlying state-level model. They do not, however, explicitly take into account alternative scenarios for shifts in demographic and behavioral trends that could introduce additional uncertainty to the path of the LFPR going forward.

Figure 14. Particpation Rates in Baseline Scenario
(Percent)
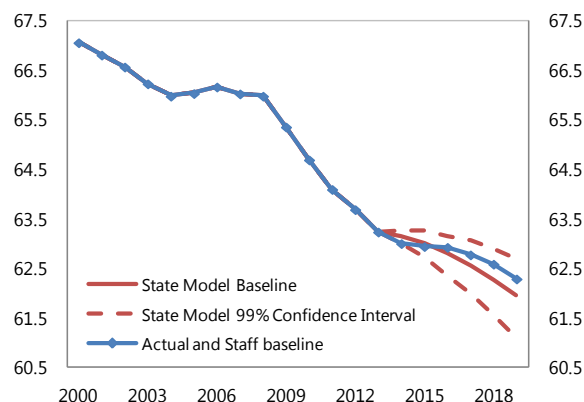
State Model Baseline
State Model 99% Confidence Interval
Actual and Staff baseline

Sources: U.S. Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, and IMF staff estimates.
Note: The 99 percent confidence band is obtained from 1000 clustered bootstrap resamples with replacement (clustered at state level).

31.   **Staff's baseline scenario is based off the forecast from the state-level panel regression models, but applies some additional judgment and utilizes census population forecasts**. Essentially, based on the preceding analysis, the baseline forecast is made up of three components: (i) a pure demographic effect, which holds age-group participation rates constant at 2007 levels and uses the census baseline population forecast; (ii) a cyclical bounce-back as the job market improves

benchmarked off the state-level analysis; and (iii) judgment regarding non-demographic structural forces (i.e., college enrollment, share of students working, and retirement patterns).[8]

32.   **Staff's baseline scenario has a more front loaded cyclical bounceback than the state model projection, and the LFPR at 2019 is around 0.3 p.p. higher**. In the baseline, the LFPR of older and younger workers embed some additional judgment that the statistical model is not designed to capture. Specifically, the LFPR of younger workers is expected to bounce-back by around 2p.p. as school enrollment declines a little more (closer to 2007 levels) and more students start working as job opportunities improve and given the need to pay off student loans. Older workers, however, are forecast to have no bounce-back given their participation rates continued going up during 2007-13 and as the recovery of wealth allows many who postponed retirement to finally do so. The projections are younger and older workers are also consistent with the cyclical sensitivities presented in Figure 8. However, the overall cyclical bounceback in the baseline is the same as in the state model (middle of the range given in Table 9) but more is taking place during 2014-16. In sum, the aggregate participation rate is roughly flat for the period 2014-16, as the cyclical and non-demographic structural forces offset the demographic effect, before resuming a downward trend from 2017 as the weight of the aging population begins to dominate. The higher LFPR in 2019 in the baseline relative to the state model projection is mainly driven by using actual Census population forecasts in the baseline.

33.   **Staff's baseline forecast is also slightly above CBO's forecast over the medium term**. CBO has a similar projection to staff for the end of 2014 (63 percent). But they have downward pressure from population aging outweighing the cyclical bounceback by more than staff over the medium term, resulting in the LFPR declining to 62.5 by end-2017 (relative to staff's forecast of 62.8 percent). Deutsche Bank (2013) uses a VAR model to estimate that, as economic conditions improve, the participation rate should approach 63 percent by end-2014.

34.   **There are some important risks around staff's baseline that are beyond the confidence bands generated from the state-level model**. As noted earlier, the confidence bands do not take into account alternative scenarios for shifts in demographic and behavioral trends that could introduce additional uncertainty to the path of the LFPR going forward. Specifically, as noted in previous studies, forecasting LFPRs for youths and older workers has proven to be incredibly challenging given various structural changes (Aaronson et al, 2006). For example, it's not easy to predict what will happen to college enrollment. Will it continue the very recent decline as job prospects improve and the cost of college goes up, or will a rising skill premium encourage further enrollments? For older workers, which forces will dominate: increasing wealth or rising longevity and better health? And how do we forecast longevity and health?

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[8] The census also produces three alternative population forecasts based on different migration assumptions. As we show in Annex (II), this makes little difference to the path of the aggregate LFPR, but can make a substantial difference to the path of labor force growth.

Labor Market Slack

35.   **Estimation of a trend LFPR and forecasting the actual one allows construction of a broader measure of labor market slack**. The BLS produces various measures of labor market slack in addition to the unemployment rate (Figure 15). The broadest measure includes marginally attached workers and those working part time for economic reasons. This shows that while the unemployment rate has fallen to well within 1 percentage point of most estimates of the NAIRU, substantial slack still exists, especially given the number of part-time workers for economic reasons. Below an alternative measure is constructed, following Erceg and Levin (2013). Specifically, the "employment gap" or deviation of the employment-to-population from its natural rate is

Figure 15. Components of U-6 Rate
(In percent of labor force)

Sources: U.S. Bureau of Labor Statistics, and IMF staff estimates

constructed. This can be approximated as the weighted sum of the unemployment and participation gaps (equation 3). We add to this measure, however, by taking account of "part time workers due to slack work or business conditions", which shows up as an adjustment to the unemployment gap in equation 3.[9]

(3) $$egap \approx (1 - u^*)(LFPR - LFPR^*) + LFPR^*(u - u^*)$$

36.   **The sizeable participation and part-time work gaps point to significant labor market slack that will take a while to eliminate** (Figure 16). The broader employment gap peaked in 2010 at 3.5 percent, when over half the gap reflected the unemployment gap. The overall gap fell to around 2.5 percent in 2013, with a declining unemployment gap offset by a rising participation gap. Looking ahead, we expect the participation gap will only close slowly, suggesting significant labor market slack will remain over the next few years.

Figure 16. Employment Gap
(In percent of population)

Sources: U.S. Bureau of Labor Statistics, and IMF staff estimates

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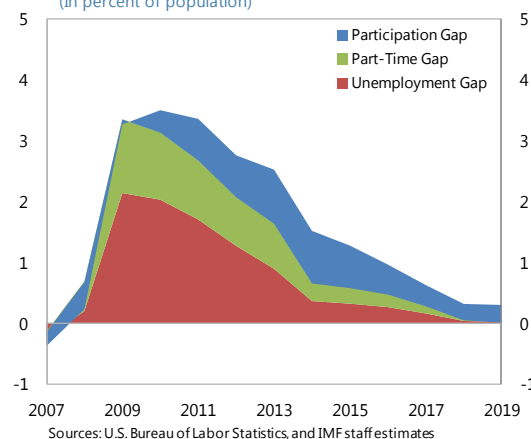
[9] The adjustment suggested by Citibank (2014) is followed. Specifically, the part time adjustment is the product of: (i) the change in part time workers due to slack work or business conditions relative to the average for 1997-2007; and (ii) (1-the ratio of average part time hours/average full time hours). This adjustment is added to the unemployment rate (i.e. weighted by the trend LFPR).

F. Conclusions and Policy Implications

37.   **The key chapter finding is that while around ¼-⅓ of the post-2007 decline is reversible, the LFPR will continue to fall given population aging**. With participation rates for older workers lower than for prime age workers, demographic models suggest that aging of the baby boom generation explains around 50 percent of the near 3p.p. LFPR decline during 2007-13. State-level panel regression analysis is used to tie down the cyclical effect, which is estimated to account for 33-43 percent of the decline. The rest is made up of non-demographic structural factors such as increasing college enrollment and fewer students working. With some of the decline triggered by cyclical factors and non-demographic structural factors judged to be irreversible, only around a ¼-⅓ of the post-2007 decline is forecast to be reversed over the next few years. However, with population aging continuing to weigh, this reversal only causes the LFPR to flatline in the near term, and the secular decline reasserts itself once the cyclical bounceback starts to wane.

38.   **There are some important risks around staff's baseline forecast**. In particular, over the last 20 years, forecasting LFPRs for youths and older workers has proven to be incredibly challenging given various structural changes. For example, it's not easy to predict what will happen to college enrollment. Will it continue the very recent decline as job prospects improve and the cost of college goes up, or will a rising skill premium encourage further enrollments? For older workers, which forces will dominate: increasing wealth or rising longevity and better health? And how do we forecast longevity and health?

39.   **Macroeconomic policy should remain accommodative for a while given sizeable labor market slack**. This slack goes beyond that signaled by the unemployment rate, and takes account of the LFPR being below trend and many employees working part time "involuntarily". Moreover, the numbers of long-term unemployment are still higher than at any time pre-2007 since WWII, suggesting that further hysteresis effects (e.g., loss of skills, discouragement) could still develop.

40.   **Policies to enhance labor supply and help offset the headwinds to potential growth from aging will also be important**. The main drag to potential growth in staff's forecast is expected to come from aging and the retirement of the baby-boom generation. Indeed, staff projects the potential labor force to expand at below ½ percent per year over the medium term, half the average growth rate seen in 2000–13 and well below the long-run average of 1½ percent. Policy priorities include: (i) enhancing training and job search assistance programs (such as sectoral training), particularly those that engage industry and higher education institutions; (ii) better family benefits (including childcare assistance) to reverse the downward trend in female labor force participation rates; (iv) modifying the disability program to allow for part-time work by those receiving benefits; reducing the penalties for working during the application process; and re-examining eligibility rules to present misuse (especially for disability related to mental illness); (v) providing greater visa opportunities for high-skilled immigrants; and (v) expanding the EITC to childless workers and by lowering the age threshold from 25.

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Appendix 1. Demographic Data and Analysis

As discussed in section B, in order to disentangle the effect of population dynamics on the participation rate, the chapter adopted a two-pronged strategy. First, we considered a 'demographic' approach that relies on disaggregated population and participation data by age group (10 groups) and gender to estimate the demographic component of the decline in participation rates. And second, to investigate the behavior of specific age groups, we considered a shift-share analysis. This Annex describes these methodologies and the data used in detail, compares our results to similar studies, and discusses additional simulations on population and immigration growth based on the US Census forecasts.

We used data on labor force by gender and age groups (16-19, 20-24, 25-34, 35-44, 45-54, 55-59, 60-64, 65-69, 70-74, 75+) from the Household Employment Survey of the Bureau of Labor Statistics (BLS), for the period 1981 to present. Population data, including forecasts of population for 2014-2019, were obtained from the BLS, while the data on immigration used in the simulations described in section II of this Annex are from the US Census Bureau.

AGE-SPECIFIC DEMOGRAPHIC MODELS

Several models are considered in order to quantify the impact of demographic trends on the labor force. First, we estimate the "demographic component" of the participation rate decline by holding the participation rate of each age group constant at the level of a particular year – namely 2007 in our analysis – and letting the population shares of each group vary according to history. Doing so allows us to construct the aggregate participation rate that would have obtained if the only changes through time stemmed from changes in the population share of each group.

A second approach is to estimate participation rate trends for each age group over a specific period – e.g., the years 2000 to 2007 – and use the estimated trends to project the evolution of each age group's participation rate (Figure A.1.1.). These age-specific projections are then combined with population shares to calculate the aggregate participation rate. Note, however, that this approach comingles the effects from demographic changes (via changes in population shares) and from structural changes in the participation rates (as each group's participation rate follows its specific trend).

Figure A.1.1. Particpation Rates in Baseline Scenario
(Percent)

Sources: U.S. Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, and IMF staff estimates.

Thirdly, to quantify the relative importance of changes in the population shares and participation rates of each age group and gender, we conducted the shift-share decomposition expressed in equation A.1. As noted in Section B, the total change in the participation rate with respect to a base year equals the sum of (a) changes in the population share of each group weighted by their base-year participation rate; (b) changes in the
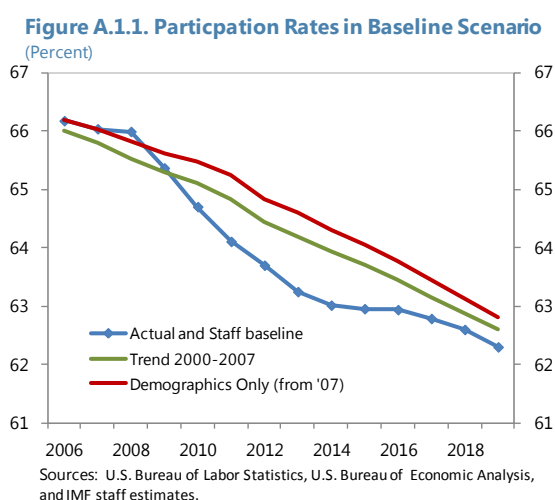
participation rate of each group weighted by their base-year population share; and (c) an interaction term that is typically small for years not too far from the base year:

(A.1) $p_t - p_0 = \sum_g \{ p_0^g(s_t^g - s_0^g) + s_0^g(p_t^g - p_0^g) + (p_t^g - p_0^g)(s_t^g - s_0^g) \}$,

where p_t stands for the aggregate participation rate, and p_t^g and s_t^g stand for the participation rate and the population share of age group *g* in year *t*, respectively.

The demographic and shift share models suggest a demographic effect of similar magnitude to estimates produced elsewhere (Table A.1). Fujita (2013) relies on the Current Population Survey (CPS) micro dataset on 'Reported reasons for non-participation' to find that retirement and disability account for two-thirds of the decline in participation between 2000 and 2013, although the decline due to retirement has taken place after 2010]. This implies that most of the decline in participation is likely to be irreversible, as retirees and disabled are unlikely to rejoin the workforce in large numbers even as job prospects improve. Deutsche Bank (2013) and CBO (2014), in turn, use similar approaches to our demographic models to examine long-term participation trends. They find that structural/demographic forces account for around 50-60% of the participation rate decline during 2007-13. Finally, Mishel *et al.*, (2012) find that the structural component– measured as the long-term trend of the participation rate – explain only one-third of the fall in participation between 2007 and 2011. However, this result partly stems from the authors' use of a longer-term trend of participation rates (for the period 1989-2007), which is consequently flatter than the trends estimated in this Chapter.

IMMIGRATION SCENARIOS

Section E discussed our baseline forecasts for the LFPR and also confidence bands for these forecasts. Besides these baseline projections, we also conducted simulations to ascertain the potential effects on the labor force of different immigration scenarios, as well as constructed confidence bands around the simulations.

Table A.1. Estimates of structural component in the reduction of the participation rate (various periods, in %)

	Period	Structural Component
CBO (2014)	2007-13	50%
Deutsche Bank (2013)	2007-13	50% - 60%
Mishel, Bivens, Gould, and Shierholz (2012)	2007-11	33%
Fujita (2013)	2000-13	65%

To arrive at our results, we first computed the additional working age population under the three current Census scenarios for immigration (the so-called Middle, Low and High scenarios).[10] Then, to obtain estimates of the additional labor force under these scenarios, we further assumed that around 60 percent of the additional immigrants are male and that the participation rates for males

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[10] The Census Bureau produces these three scenarios as immigration is very difficult to forecast. The different Census scenarios maintain the same methodologies and assumptions on fertility and mortality, and differ only in the levels of net international migration assumed under each scenario.

and females are 90 percent and 50 percent, respectively (*cf.* CBO, 2011). Finally, in order to assess the accuracy of these forecasts, we used past vintages of the Census' immigration and population forecasts to compute average error forecasts, and applied these estimates to obtain confidence bands around the baseline projection (Figure A.1.2.).

Our analysis reveals that alternative immigration scenarios could have a considerable effect on the size of the labor force and hence on potential growth, but not so much on the aggregate participation rate (Figure A.1.3.). Under our baseline projections for LFPR, by the end of the decade, the labor force could have grown 4 percent compared to its level in 2013. The error bands suggest, however, that immigration could further add or detract around 1.1 to 1.4 pp to these estimates, and thus have a non-negligible impact on the size of the labor force and potential growth. However, the impact on the participation rate would not be sizeable, as in the scenario both the labor force and working age population would be growing at a similar pace.

Figure A.1.2. Population Scenarios: labor force
(index 2013 = 100)

Legend: Baseline; High migration upper bound; Low migration lower bound

Sources: U.S. Census Bureau

It's also worth noting that existing proposals for immigration reform could have a large impact on the size of the labor force (*cf.* CBO, 2013). The CBO estimates that the implementation of the Senate Bill S.744[11] would lead to a further increase (relative to CBO's baseline) in the labor force of around 6 million people (about 3½ percent) by end-2023, as well as raise GDP by 3.3 percent. The increase in GDP would come via the effects of a larger labor force as well as higher demand from an expanded population.

Figure A.1.3. Participation Rate Scenarios
(In percent of total population)

Legend: Baseline; High migration upper bound; Low migration lower bound

Sources: U.S. Census Bureau and U.S. Bureau of Labor Statistics

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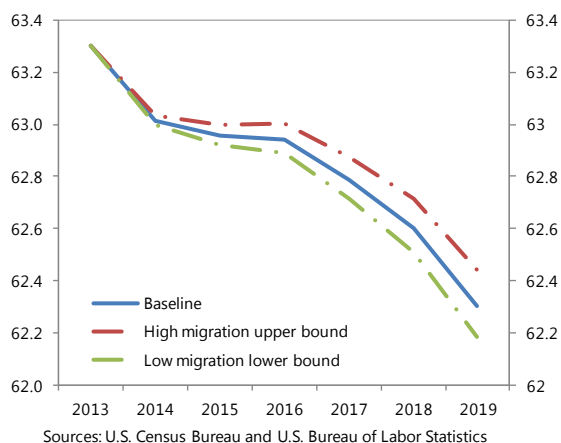
[11] Bill S.744, Border Security, Economic Opportunity, and Immigration Modernization Act

Appendix 2. State-Level Regression Model

EMPIRICAL APPROACH:

The underlying model in levels: To estimate the cyclical effect of labor demand on the participation rate, we start with a linear model determining the level of participation rate as:

(1)
$$PR_{st} = \alpha_s + \delta_{1s} * trend_t + \delta_{2s} * trend_t^2 + \sum_{k=0}^{l} \beta_k * cycle_{s,t-k} + \varepsilon_{st}$$

As at the national level, the participation rate in state *s* and year *t* may follow a linear and quadratic trend that accounts for aggregate aging dynamics and other structural forces not related to the business cycle. We allow the trends to be state-specific, accounting for evolution of structural forces that can follow different paths across states. Once de-trended, the participation rate evolves around a state-specific mean, which should capture unobservable state characteristics such as climate, geographic location, industrial specialization, etc, which in turn may affect the demographic composition and hence the mean participation rate across states.

The main variable of interest is the measure of the state-specific business cycle (*cycle*) which should capture the annual variation in labor demand across states. The coefficient β_k therefore gives the effect of cyclical forces on the participation rate, allowing the adjustment to occur gradually over time via the lag structure.

Model in first differences: Taking first differences of the level equation (1), we arrive at the following equation for the *change* in the participation rate:

(2)
$$\Delta PR_{st} = \delta_{1s} + \delta_{2s} * trend_t + \sum_{k=0}^{l} \beta_k * \Delta cycle_{s,t-k} + \xi_{st}$$

There are several advantages to estimating the model in first differences as opposed to levels: first, the level variable is likely non-stationary, which conventional unit root tests in fact suggest, possibly rendering the level estimation spurious. Second, the level of participation rate is highly persistent so that the level residuals are strongly auto-correlated, while this is no more the case in first differences. While the state-specific intercept captures state-specific annual change in LFPR during the sample period, the state-specific trend in the changes allows for some curvature in the dynamics, as the evolution of LFPR at the aggregate level as well as in all states has been highly non-linear (both features result directly from the levels equation (1)).

We measure state labor demand or the cycle using two different measures of the employment gap at state level. The employment gap is calculated as the difference between payroll or household employment and its state-specific trend using a HP filter. As we want to measure changes to labor demand, we prefer these employment gap measures to the unemployment rate, which inevitably

responds to endogenous changes in labor supply and the LFPR itself. To avoid that the HP filter fits a trend that is too close to actual data toward the end of the series, we adjust the end points as follows: For each state, we calculate the average annual employment growth between 2002 and 2005 (the last two years before the crisis where aggregate employment was at trend and unemployment close to NAIRU), and for all years starting with 2006, we impose trend growth rate to equal this average growth rate.

Instrumental Variable: The trend captures low frequency movements in employment potential, but cannot account for short-term shocks to labor supply, e.g. reactions to policy such as unemployment insurance benefit extension or temporary tax changes which also often vary at the state level. To control for these and other sources of endogeneity, we estimate equation (2) both with OLS and 2SLS, where the employment gap is instrumented by a measure of predicted employment growth based on a state's industry mix (*imix*):

(3) $$imix_{st} = \sum_{j=1}^{J} \bar{\theta}_{sjt} * \Delta e_{jt}$$

This industry mix variable, often called the Bartik shock (Bartik, 1991), captures changes to a state's labor demand through an average of industry-specific employment growth at the national level (Δe_{jt}), weighted by the state's share of employment in each industry $\bar{\theta}_{sjt}$ (averaged over the previous five years). In other words, this is a measure of employment growth that would result if each industry's employment growth coincided with the national rate, and the sectoral distribution of employment by state did not fluctuate significantly from year to year. It is thus plausible to assume that this predicted employment growth is exogenous to state-specific shifts in labor supply.

REGRESSION RESULTS:

Table A.2 below summarizes various regression results of estimating equation (2), using the household employment variable (as opposed to payroll employment, for which the same table is in the main text) to construct the employment gap as a measure of the state business cycle. The trend-cycle decomposition and end-point adjustment follows the same procedure as for the payroll employment (discussed above).

Table A.2 Regression results using household employment.

	OLS	2SLS				
		with lags	pop. weighted	1978-2007	2007-2012	

Dependent variable: Δpr_t

	OLS	with lags	pop. weighted	1978-2007	2007-2012
$\Delta egap_t$	0.24***	0.15***	0.11***	0.11***	0.15***	0.04
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.04)
$\Delta egap_{t-1}$			0.07***	0.07***	0.06***	0.10***
			(0.01)	(0.01)	(0.02)	(0.02)
$\Delta egap_{t-2}$			-0.00	0.03**	0.01	0.03
			(0.01)	(0.01)	(0.02)	(0.02)
$\Delta egap_{t-3}$						0.03
						(0.02)
Hausman test (p-val.)		0.000	0.000	0.000	0.000	0.000
1st stage:			*Dependent variable: $\Delta egap_t$*			
$imix_t$		0.56***	0.57***	0.63***	0.54***	0.74***
		(0.02)	(0.02)	(0.03)	(0.03)	(0.06)
F-stat.		951.6	771.8	484.2	439.9	127.4
N	1785	1734	1632	1632	1428	306
R^2	0.416	0.393	0.348	0.371	0.333	0.362

Note: Column 1 estimates equation (2) with OLS and no lags in the employment gap variable. Column 2 instruments the contemporaneous employment gap with the industry mix based employment growth in equation (3). Columns 3 to 6 introduce further lags in the employment gap variable. Columns 4 to 6 weight the data by the average working-age population in each state. Column 5 and 6 splits the sample to sub-samples before and following the Great Recession. The Hausman test result reports the p-value of the null hypothesis that the contemporaneous employment gap is exogenous. The 1st stage panel reports the first stage coefficient for the contemporaneous employment gap and the first stage F-statistics. All specifications also include state-specific intercepts and trends (not shown). Standard errors are robust to heteroskedasticity and auto-correlation (using Newey-West kernel). ***, ** denote 1 and 5 percent statistical significance respectively.

Compared with the estimates using the payroll employment gap as the independent variable in Table 3 in the text, a few points stand out. First, the industry mix variable continues to be a very strong instrument for the employment gap if the household measure is used (positive, statistically significant first stage coefficients and large F-statistics). Second, the bias of OLS is positive and substantially larger than when using payroll employment. This is plausible, as household employment encompasses a wider definition of employment, including self-employment, and hence is more prone to an endogenous response to labor supply. As an increase in labor supply raises both the LFPR as well as self-employment, the OLS coefficient is biased upward. Moreover, the household employment variable is derived from the same survey as the LFPR, introducing possible mechanical correlation that could render OLS regression spurious. The instrumentation is therefore even more important when using the household employment variable to measure labor market slack, as is reflected in the Hausman test results.

Finally, when instrumenting using the industry mix variable, the estimates using household employment deliver very similar results. Accounting for sufficient lags, the total effect of a 1 percent increase in the employment gap leads to a total of 0.2 p.p. increase in LFPR within 2 years, the same as obtained using payroll employment (columns 3 to 5). Also, similar to the baseline result, the cyclical response has been more sluggish and persistent following the Great Recession, thought still adding up to the same total effect as estimated with the whole sample.

U.S. TOTAL FACTOR PRODUCTIVITY SLOWDOWN: EVIDENCE FROM THE U.S. STATES[12]

A. Productivity Slowdown: The Debate

41.   **U.S. total factor productivity growth has slowed since mid-2000s**. After growing at about 1¾ percent per year during 1996–2004, average total factor productivity (TFP) growth rate has halved since 2005 (Chart). This suggests that the reasons of the slowdown go beyond the effects of the Great Recession. Understanding what is driving the slowdown is key to assessing the future potential growth of the U.S. economy (CEA, 2014).

United States: TFP and Real Output Growth
(Percentage change; business sector)
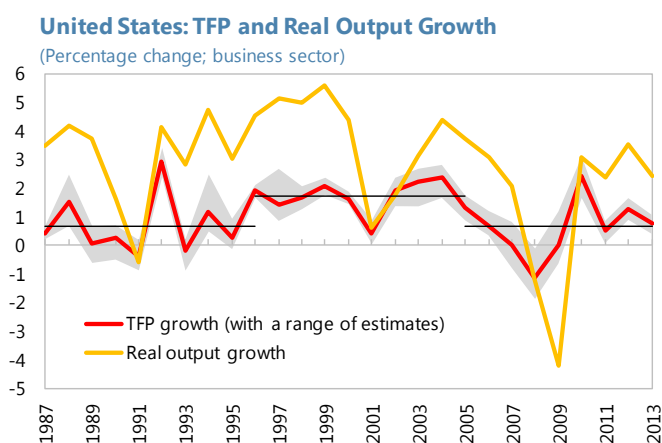
Sources: BLS; OECD; Fernald (2014); and IMF staff estimates.

42.   **Some argue that the slowdown in TFP growth reflects the reduced ability of the U.S. economy to benefit from technological advances**. Gordon (2012 and 2013) suggests that technological innovation has become marginally less important for growth. Fernald (2014) argues that the recent subdued pace of productivity growth is merely the return to more normal rates following nearly a decade of extraordinary gains from the information technology (IT) revolution. A few others are more optimistic on the room for technology to keep boosting TFP growth in the future, as they see still room for positive knockout effects from past technological advances, especially in services (e.g., Baily, Manyika, and Gupta, 2013; Byrne, Oliner, and Sichel, 2013), or are confident on the continuing transformational nature of recent IT innovations (Bernanke, 2013).

43.   **But TFP growth depends on many factors besides advances in technology**. In general, TFP captures the efficiency with which labor and capital are combined to generate output. This depends not only on businesses' ability to innovate, but also on the extent to which they operate in an institutional, regulatory, and legal environment that fosters competition, removes unnecessary administrative burden, provides modern and efficient infrastructure, and allows easy access to finance (for a literature survey, see for example, Syverson, 2011, and Isaksson, 2007).[13] A few authors

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[12] Prepared by R. Cardarelli and L. Lusinyan (both WHD). The authors are grateful to Steven Yamarik for helpfully providing the state-level capital stock and investment estimates, and to Andrew Levin, Juan Sole, Jason Sorens, and Andrew Tiffin for helpful discussions and comments.

[13] In practice, TFP is usually obtained as a residual in estimates of a production function, once the contributions from measured inputs have been estimated. Thus, growth in output not directly attributable to changes in labor and capital would be captured in TFP, including unobserved factor utilization and measurement errors.

suggest that the slowdown in U.S. TFP growth reflects a more secular loss of market "dynamism" given the importance of business churning, "creative destruction", business startups, and young firms (Chart) to generate productivity gains though more efficient resource allocation and greater innovation (e.g., Haltiwanger, 2011). Furthermore, Haltiwanger, Hathaway, and Miranda (2014) show that the decline in firm formation and entrepreneurship has been

United States: The Declining Share of Young Firms
("Young firm"=aged 5 years or younger)
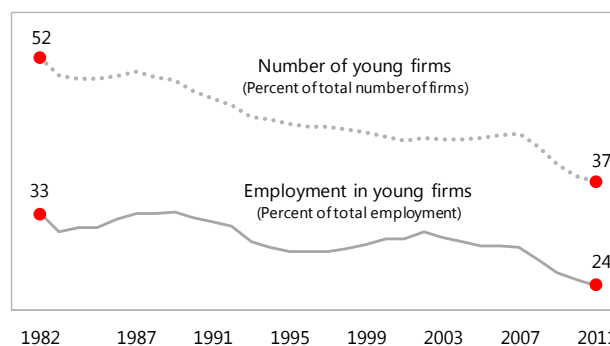
Sources: U.S. Census Bureau Longitudinal Business Database 1977-2011; and IMF staff calculations.

especially pronounced in the high-tech sector after 2002. The decline in dynamism is also evident in the U.S. labor market, with slower geographic mobility and labor turnover only partly reflecting population aging and a higher share of older firms (Hyatt and Spletzer, 2013; and Tarullo, 2014).[14]

44.   **The objective of this chapter is to shed light on the slowdown of U.S. TFP growth using evidence from TFP estimated across U.S. states over the last two decades**. In particular, we focus on three main questions:

- *Has the TFP growth slowdown been similar across U.S. states?* Fernald (2014) and earlier studies (Bauer and Lee, 2006; Daveri and Mascotto 2006) look at *labor productivity*, which captures cross-state variation of both TFP and capital deepening. Most likely reflecting data limitations, little is known about state-level TFP developments in recent years.[15]

- *To what extent can aggregate U.S. TFP growth benefit from low-productivity states converging to high-productivity ones?* Higher aggregate TFP growth can be achieved by shifting the production frontier outward (through technological innovations) for all states, but also by closing the gap between the "frontier" and "laggard" states (by tackling inefficiencies that prevent all states to be on the production frontier). Identifying relative contributions of these factors to TFP growth would provide further insights to productivity prospects and policy options.

- *Can we exploit the variation of TFP growth and its main determinants across the U.S. states to speculate on what factors and policies are most important for TFP growth*? To the extent that the

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[14] Hyatt and Spletzer (2013) argue that while the decline in employment dynamics is concentrated in recession periods, from which it has never fully recovered, it remains an open empirical question whether the decline indicates increasing labor market adjustment costs or better job matching.

[15] Blanco, Prieger, and Gu (2013) and Caliendo and others (2014) are notable exceptions but they do not cover the period after 2007, and while the former focuses primarily on the impact of research and development, the latter examines aggregate implications of disaggregated (by region and sector) productivity changes and the role of regional trade. Sharma, Sylwester, and Margono (2007) look at sources of state-level TFP growth over the period of 1977–2000.

cross-sectional (across U.S. states) variation in TFP experiences allows us to robustly identify a few key factors associated with TFP growth, these could be the focus of policy actions.

45.   **Our results suggest that TFP growth in the United States can benefit especially from policies that promote investment in human capital and research and development**. We find that the slowdown in TFP growth from mid-2000s has been widespread across the U.S. states and does not seem to be stronger in those states which rank higher in terms of production or usage of IT. Our analysis suggests that the TFP slowdown across the U.S. states owes more to a declining efficiency in combining factors of production than to a diminishing pace of technological progress. We find that higher educational attainment, greater spending on research and developments (R&D), and a larger financial sector are associated with lower "inefficiencies" across U.S. states. Our analysis of TFP determinants across U.S. states over the last two decades suggests that human capital is a significant factor associated with TFP growth.

B.   Empirical Analysis

46.   **Our empirical analysis is carried out in three stages**. First, we estimate state-level TFP growth using a standard Cobb-Douglas production function with time-varying and state-specific labor shares. Second, we use a stochastic frontier analysis to assess the relative contributions to TFP growth from common technological trends and state-specific technical efficiency. Third, we analyze the determinants of TFP growth across U.S. states using panel data models that relate TFP growth to human capital, innovation, infrastructure, taxation, and regulatory framework.

47.   **There are a number of important caveats to analyzing TFP trends at U.S. state level**.[16] In particular, there is no data on capital stock or services for U.S. states. We use data from Garofalo and Yamarik (2002) and Yamarik (2013), who start from the net national capital stock at the industry level (from the Bureau of Economic Analysis; for each one-digit industry including services and agriculture) and allocate it to individual states' industries based on their share of national industry income.[17] This approach assumes that the capital-to-output ratio within each industry is the same across U.S. states, which could lead to an underestimation of TFP in states where capital productivity is high, and therefore may imply understating the actual variation in TFP across states. Also, our labor input variable is employment in the private sector, rather than hours worked: this means that changes in labor utilization (that is, in hours per worker) would be included in our TFP estimates. The accurate measurement of TFP is an exercise traditionally fraught with measurement errors and goes beyond the objectives of this chapter.[18] Rather, our main objective is to exploit the variation in our

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[16] For details on data sources and description, see Appendix 1.

[17] For example, Sharma, Sylwester, and Margono (2007), LaSage and Pace (2009), and Blanco, Prieger, and Gu, (2013) use capital stock data constructed by Garofalo and Yamarik (2002) and Yamarik (2013), while Turner, Tamura, and Mulholland (2013) construct alternative series of state-level physical capital covering 1947–2001, which show very high correlation with the Garofalo-Yamarik series (for further discussion, see also Panda, 2010).

[18] See, for example, Hauk and Wacziarg (2009) for a discussion of measurement error in growth regressions.

TFP estimates across U.S. states to assess whether they are significantly associated with a few underlying factors that have traditionally been related to TFP growth.[19]

Is Productivity Growth Different Across U.S. States?

48.   **The slowdown in TFP growth after mid-2000s has been widespread across U.S. states, but there have also been some significant differences (Figure 1, Appendix Figure A1)**. While for the U.S. as a whole the TFP growth slowed about 1¾ percentage points on average in 2005–2010 relative to 1996–2004, the state-level estimates range from a decline of over 3 percentage points in New Mexico and South Dakota to a relatively modest (below 1 percent) decline in ten states, with Oregon standing as a clear outlier in terms of a sustained high pace of TFP growth over the whole period (Appendix Figure A2).

Figure 1. Deceleration in Average TFP Growth, 2005–2010 vs. 1996–2004
(Percentage change)
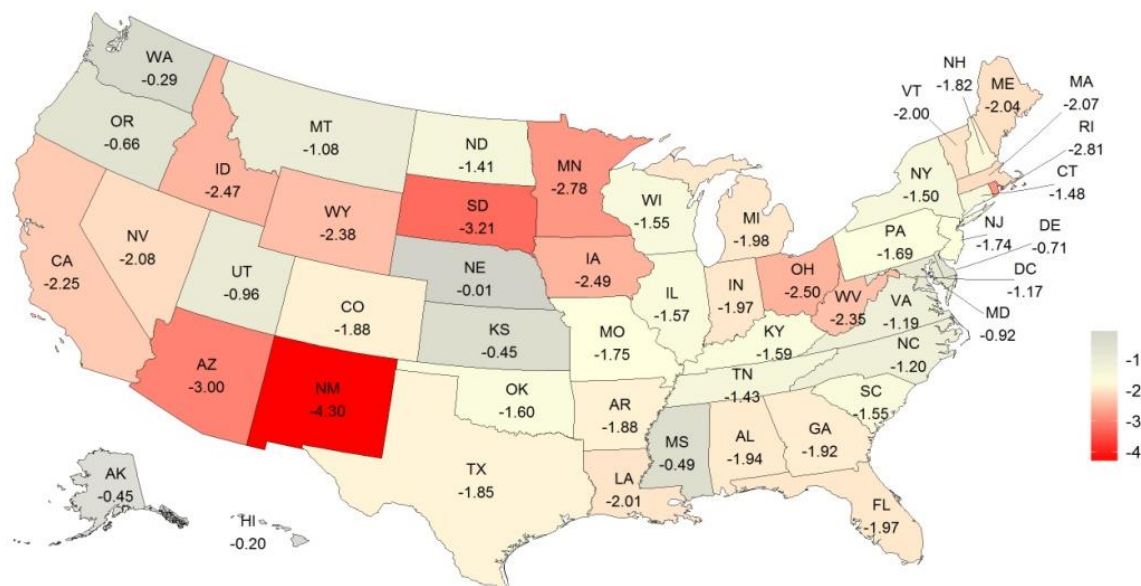
Source: IMF staff estimates.

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[19] Two different robustness checks support our TFP estimates: first, the GDP-weighted average of state TFP growth follows very closely national aggregate TFP growth estimates from a range of sources (including BLS). Second, our state TFP growth estimates are strongly correlated with those from Caliendo and others (2014) who construct state-level TFP by aggregating industry-level TFP estimates using the industry (revenues) shares within each state as weights.

Figure 2. IT Specialization Across U.S. States

IT Producing States
(Index; U.S.-wide output share of IT-producing industries in total private industries=1)

State	Value
WA	0.49
OR	8.33
MT	0.07
ND	0.50
MN	1.61
NH	2.55
VT	3.29
ME	0.46
MA	2.41
ID	4.72
WY	0.05
SD	1.89
WI	0.70
MI	0.25
RI	0.56
NY	0.53
CT	0.44
NV	0.16
CA	1.93
UT	0.73
NE	0.46
IA	0.52
OH	0.34
PA	0.44
NJ	0.48
DE	0.41
CO	1.27
IL	0.53
IN	0.40
WV	0.09
VA	0.46
DC	0.08
KS	0.33
MO	0.23
KY	0.46
MD	0.73
NC	0.70
AZ	4.03
NM	5.21
TN	1.03
SC	0.31
OK	0.24
AR	0.27
MS	0.18
AL	0.58
GA	0.24
AK	0.01
TX	1.45
LA	0.06
HI	0.01
FL	0.52

Legend: 5, 3, 1
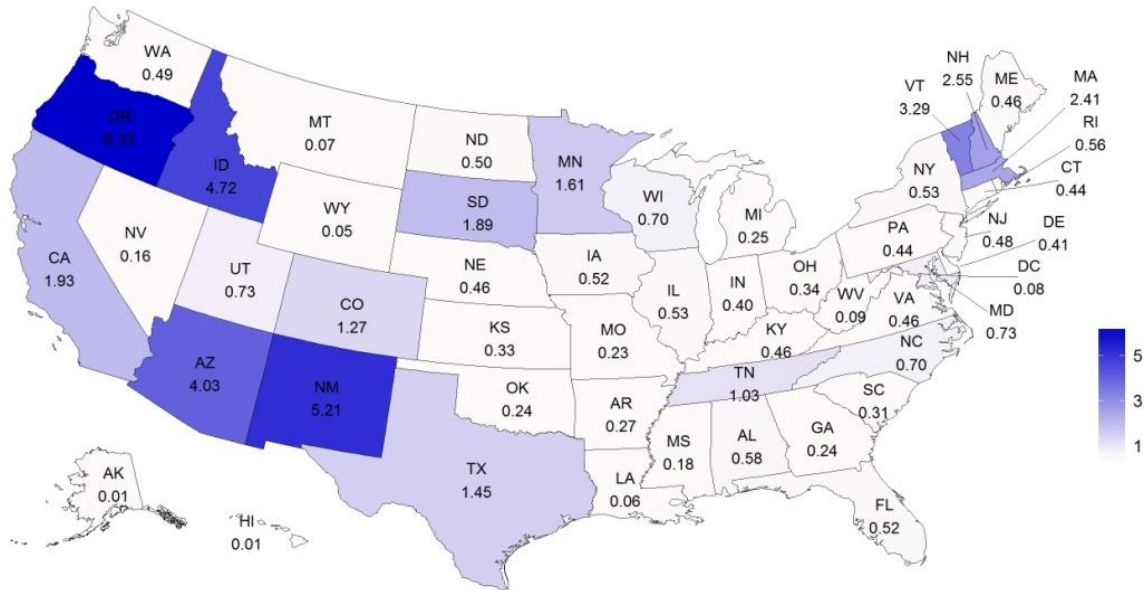
IT-Intensive Using States
(Index; U.S.-wide output share of IT-using industries in total private industries=1)

State	Value
WA	1.00
OR	0.84
MT	0.88
ND	0.97
MN	1.05
NH	0.99
VT	0.95
ME	1.01
MA	1.04
ID	0.88
WY	0.59
SD	1.10
WI	0.94
MI	1.11
RI	1.07
NY	1.12
CT	1.11
NV	0.97
CA	0.93
UT	1.03
NE	0.94
IA	0.98
OH	1.04
PA	1.01
NJ	1.04
DE	1.27
CO	1.01
IL	1.08
IN	0.97
WV	0.86
VA	0.99
DC	1.07
KS	1.03
MO	1.05
KY	0.98
MD	1.03
NC	0.97
AZ	1.06
NM	0.81
OK	0.92
AR	0.89
TN	1.04
SC	0.98
MS	0.90
AL	0.93
GA	1.04
AK	0.81
TX	0.91
LA	0.71
HI	0.93
FL	1.06

Legend: 1.2, 1.0, 0.8, 0.6
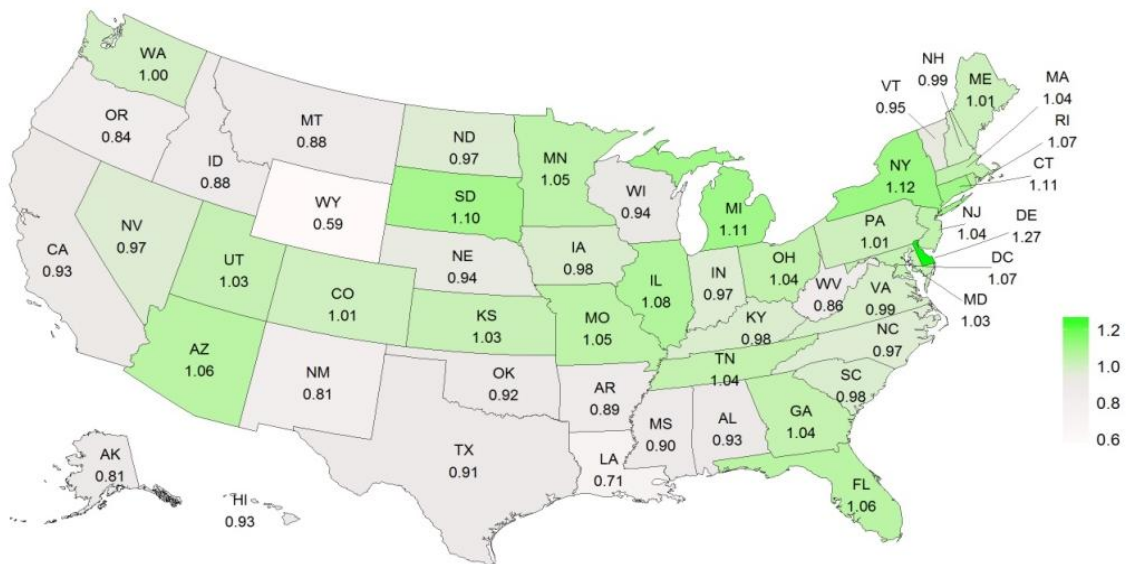
Source: IMF staff estimates.

49.   **There is little evidence that the TFP growth slowdown was significantly higher in those states which are most intensively producing or using information technology**. We measure the extent to which a state is specialized in IT production and the degree to which it uses IT given its industry composition and industry-level IT-intensity estimates (see Appendix 1). Figure 2 shows the two measures of IT-specialization prior to the productivity slowdown, and suggests that IT production was more geographically concentrated across U.S. states than IT usage (as in Daveri and Mascotto, 2006). A series of statistical tests (similar to Stiroh, 2002, and Daveri and Mascotto, 2006) using various measures of IT-specialization show no significant additional TFP deceleration for IT-producing or IT-intensive states relative to other states (see Appendix 2, Tables A1 and A2). In particular, the two states—New Mexico and Oregon—with the highest degree of specialization in IT-production and a similar degree of IT-intensity had very different productivity and growth outcomes.

Technological Progress vs. Efficiency

50.   **An alternative way to analyze TFP growth is to decompose it more explicitly into contributions from technological progress and improvement in efficiency**. Following the common approach in the stochastic frontier analysis (SFA), we assume that inefficiencies potentially drive a wedge between actual production and the production frontier, given the existing state of technology (Box 1). In this framework, technological progress (proxied by a time trend) shifts the production frontier upward for all states, while an improvement in technical efficiency (captured by state-/time-specific variables) moves states towards the production frontier.[20]

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[20] Using SFA with a translog production function, Sharma, Sylwester, and Margono (2007) decompose TFP growth for the lower 48 U.S. states over the period 1977–2000 and show that TFP growth mainly stemmed from technological progress, while differences in efficiency change explained cross-state differences in TFP. Oil and coal producing states underwent the greatest declines in efficiency, while those with larger financial sectors experienced greatest increases. Also, human capital, urbanization, and shares of non-agriculture and financial sectors were positively associated with efficiency. Jerzmanowski (2007) also finds that the TFP growth in the U.S. between 1960 and 1995 was entirely due to the growth of technology while the average efficiency change was zero.

Box 1. Stochastic Frontier Analysis

For a given state s, assume

$$Y_{st} = f(X_{st}, t)\theta_{st}e^{v_{st}}$$

where Y is output of the state, $f(\cdot)$ is production function of inputs X and technological change t, $\theta \in (0,1]$ is the level of efficiency, with $\theta = 1$ indicating that the state is achieving the optimal output with the technology embodied in the production function $f(\cdot)$, and e^v is a random shock. For a log-linear production function with two inputs (labor and capital), a time trend to proxy a common technology, and $u_{st} = -\ln(\theta_{st})$ denoting inefficiency, such that

$$y_{st} = \beta_0 + \beta_L x_{L,st} + \beta_K x_{K,st} + \beta_t t + v_{st} - u_{st}$$

the point estimates of technical efficiency (TE) can be derived via $E[exp\{-u_{st}|\varepsilon\}]$, where $\varepsilon = v_{st} - u_{st}$ is the model error term comprised of the two independent, unobservable error terms. The coefficient $\widehat{\beta_t}$ on the time trend represents the change in the frontier output caused by technological change. Furthermore, Kumbakhar and Lovell (2000) show that a change in TFP, defined as output growth unexplained by input growth, can be expressed as

$$\Delta TFP = \Delta T + \Delta TE + (\epsilon - 1)\left[\frac{\epsilon_L}{\epsilon}\Delta x_L + \frac{\epsilon_K}{\epsilon}\Delta x_K\right]$$

where $\Delta T = \widehat{\beta_t} = \frac{dy}{dt}$ is technological change, $\Delta TE = -\frac{du}{dt}$ is change in technical efficiency, and $\epsilon_L(\epsilon_K)$ output elasticities with respect to labor (capital), with $\epsilon = \epsilon_L + \epsilon_K$ specifying returns to scale ($\epsilon = 1$ is the case of constant returns to scale).

Specifications for u_{st} vary, and in our analysis, we use two versions of time-varying inefficiency (having looked at other specifications as well, including time-invariant inefficiency and "true" fixed-effects models, see, Belotti and others, 2012).

- Time-varying inefficiency with convergence (or decay specification): $u_{st} = exp\{-\eta(t - T_s)\}u_s$, where T_s is the last period in the sth panel, and η is the decay parameter, such that when $\eta > 0$, the degree of inefficiency decreases over time (i.e., converges 'down' towards the base level of inefficiency in the last period $t = T_s$), and when $\eta < 0$, the degree of inefficiency increases over time.

- Time-varying conditional inefficiency: $u_{st} = z_{st}\delta + w_{st}$, where z_{st} is a vector of explanatory variables associated with technical inefficiency of production in state s. Parameters of the stochastic frontier and the model for the technical inefficiency effects are simultaneously estimated with a maximum likelihood method (Battese and Coelli, 1995).

51. **Our results show that technological change has been relatively stable, while technical efficiency has slowed**. Rolling-window estimates of the SFA model over the period 1995–2010 suggest that the production frontier has been shifting up at a relatively constant rate of about 1 percent per year (the solid black line in Chart), close to the estimates found in the literature (e.g., Jerzmanowski, 2007) (Appendix 2, Table A3). The estimated technical efficiency declined over time, with the average state moving slightly away from the frontier (the dashed blue line in the Chart).[21]

U.S. States: Sources of TFP Growth
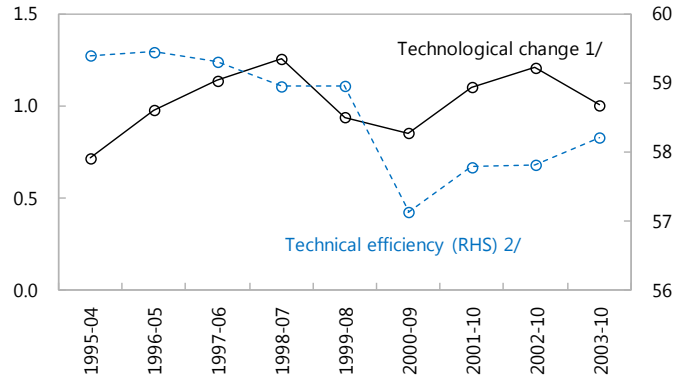
Source: IMF staff estimates.
1/ Growth rate; 2/ average actual output in percent of production frontier.

52. **There is, however, large variation in efficiency rates across states**. On average, over the whole period, Delaware was found to be quite close to the production frontier, while Oklahoma, West Virginia, and Montana were those furthest away from it (Chart and Appendix Figure A3). Staff estimates that if all states with lower-than-average efficiency converged to the average efficiency, average aggregate output per worker would have been about 3 percent higher than its actual level in 2010.

Production Frontier, 1996 vs. 2010
(Thousands of real 2005 dollars)
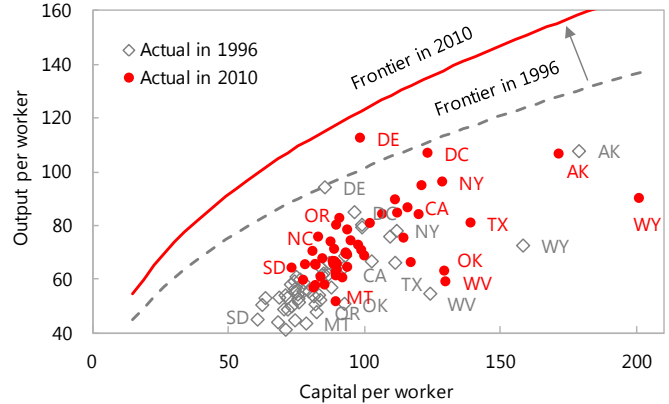
Source: IMF staff estimates.

53. **Investment in human capital and R&D appear to reduce estimated inefficiencies**. Using an SFA model which allows for conditional inefficiency effects (Battese and Coelli, 1995), we test whether we can attribute the variation in inefficiency across states to differences in a number of productivity-friendly underlying factors (Appendix 2, Table A4).[22] We find statistically significant and robust results showing that states with greater human capital (as proxied by years of schooling, especially elementary and tertiary educational attainment) tend to be have smaller inefficiencies.[23] A greater share of total R&D spending in GDP also tends to lower inefficiencies, in addition to (potentially) contributing positively to technological progress. Possibly reflecting the role of financial

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[21] Technical efficiency estimates are on a lower side of the estimates found in the literature for the U.S. states: for example, mean efficiency in Sharma, Sylwester, and Marganon (2007) is estimated at 76 percent.

[22] Note that this exercise is looking at the factors that may explain the shortfall of actual output from production frontier which may or may not be the same factors that are associated with TFP growth discussed in the following section, since TFP growth includes changes in both technical efficiency and production frontier.

[23] In particular, a one year increase in average years of schooling is associated with about 10 percent decrease in technical inefficiency.

intermediation in resource allocation, states with a larger financial sector tend to be more efficient. In the following section, we test the impact of these factors on TFP growth within a panel data framework.

Determinants of State-Level TFP Growth

54.   **There is a vast empirical literature on the many factors that can affect TFP growth**. (e.g., Isaksson, 2007). Our focus here is on whether the variation of TFP growth across U.S. states over the last two decades can be associated with cross-state variation in education, R&D and innovation, infrastructure, tax policies, and other institutional and regulatory characteristics. To investigate these relationships, we use a number of econometric specifications, including fixed-effects regressions with three-year averages and a mean group model, which allows for parameter heterogeneity and cross-sectional dependence.[24]

55.   **Our results confirm the previous findings that investment in human capital and R&D/innovation are important factors associated with TFP growth** (Appendix 2, Table A5). In particular:

- *Education*. The average years of schooling in the U.S. increased from 13.1 in 1996 to 13.8 in 2010 (albeit slowing in 2004–06), but substantial variation remains across states: the average years of schooling vary from below 12.5 years in Mississippi and West Virginia to over 14.5 years in the District of Columbia and Massachusetts. We find a strong positive relation between the indicator of human capital and TFP growth.

- *R&D and innovation*. Total R&D expenditure in the U.S. was about 2½ percent of GDP per year in 1996–2010, about three-quarters of which performed by business sector. Business R&D has however been declining (as share of GDP) in 2000-05 and at 2 percent of GDP in 2012 is close to its 2000 peak. New Mexico has the highest total (7.5 percent of GDP) and government (4.4 percent of GDP) R&D spending, while the highest business R&D is in Michigan (4.2 percent of GDP). We find some support for a positive impact of both business R&D expenditure and, more importantly, of government R&D spending and TFP growth. Including interaction terms for both types of R&D expenditure, however, makes their combined effects statistically insignificant.

C.   Conclusions

56.   **Our analysis of TFP trends across U.S. states suggests that there is scope for policies to tackle inefficiencies and help boost productivity**. In particular, our findings show that the slowdown in TFP has not been confined to IT-producing or IT-intensive user states, and if anything,

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[24] As part of robustness tests, we have also estimated fixed-effects model with five-year averages, dynamic panel data models using system-GMM estimator, and various modifications to the specifications reported in Appendix 2, Table A5, including to control for the impact of possible outliers.

the estimated pace of technological progress has remained broadly unchanged since mid-1990s. Instead, there are signs of increasing inefficiencies and slower catching-up, which may be associated with divergence in educational attainment and R&D spending. While mindful of the differences between empirical associations and causal relations, these findings suggest that policies that promote investment in human capital and innovation may boost aggregate TFP growth.

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Appendix 1. Data Sources and Description

Output: Gross domestic product by state in chained (2005) dollars private industries is from the BEA. Data on NAICS–based private (and total) industries for 1997–2012 are extended backwards by splicing with SIC-based series for 1987–1997. Private industries account on average for more than 85 percent of total gross state product.

Labor input: Employment in the private sector is constructed as the sum of farm employment and private nonfarm employment from the BEA. Data on NAICS–based private (and total) industries for 1990–2012 are extended backwards by splicing with SIC-based series for 1987–1989.

Capital input: Net private capital stock data by state, in chained 2005 dollars, are from Yamarik (2013) up to 2007, with the extension for 2008–2010 provided by the author. Yamarik (2013) tests the soundness of the state-level capital and investment (derived from capital stock through the perpetual inventory method) data by estimating a Cobb-Douglas production function and a Solow growth model and finds that estimates of the output elasticity for capital are plausible and close to the national income share. Net private capital stock for the United States is from BEA (rebased from 2009 to 2005 as a base year).

Labor and capital shares: Following Gomme and Rupert (2004) and Blanco, Prieger, and Gu (2013), labor share of GDP is the ratio of private sector compensation of employees to the difference between private sector output and 'ambiguous labor income'. The latter is the sum of taxes-less-subsidies and proprietor income. To smooth the series, a three-year moving average of the labor share is used. Capital share is one minus labor share.

IT-producing states: Specialization in IT-production is assessed as the share of IT-producing "Computer and electronic product manufacturing" industry (NAICS code 334) in total private industries in a given state s relative to the same share for the U.S. as a whole. In particular, a synthetic index following Daveri and Mascotto (2006) is constructed as $Index_i^s = \left(\frac{Y_i^s}{Y^s}\right) / \left(\frac{Y_i}{Y}\right)$, where

Y_i^s is the output in sector i in state s, Y^s is total private industries' output in state s, Y_i is the U.S. total output in sector i, and Y is total U.S. output in private industries. A state is characterized as "IT-producing state" if the value of the index is bigger than or equal to one. Following Stiroh (2002), in order to obtain an exogenous indicator of specialization prior to the productivity slowdown, the index is calculated as the average of 2002–04.

ICT-producing states: Specialization in ICT-production is assessed as the share of NAICS-composite "Information, Communication, and Technology" sector in total private industries in a given state s relative to the same share for the U.S. as a whole. ICT aggregate includes primary ICT sectors (directly involved in manufacture of ICT equipment, software, services, repair, etc.) and secondary sectors that indirectly or partially involved in ICT industry activities or significantly dependent on ICT industries. For the construction of the synthetic index, see above.

IT-intensive user states: IT-intensity is assessed as the share of the sectors identified in Jorgenson, Ho, and Samuels (2010, Table 1) in total private industries in a given state *s* relative to the same share for the U.S. as a whole. IT-using industries are those with more than the median share of IT-intensity index, defined in turn as the share of IT-capital input (and IT services purchased) in total capital input of a given industry. For the construction of the synthetic index, see above, except the reference year here is 2005 reflecting data availability in Jorgenson, Ho, and Samuels (2010).

Educational attainment: Average years of schooling. The main data source, Turner et al. (2006) has been extended after 2000 with the data from the OECD Regional Database using elementary (6 years), secondary (12 years) and tertiary (20.52 years) attainment series to calculate the average years of schooling. The data for the total U.S. are from the Census "Table A-1. Years of School Completed by People 25 Years and Over, by Age and Sex: Selected Years 1940 to 2012."

Innovation indicators (R&D expenditure): The OECD Regional Database for state-level data on R&D expenditure by sector, R&D personnel by sector, employment in high-tech sectors, patent applications (by sector) and ownership. The data are annual covering the period of 1990–2010/2011. The original data source is the U.S. National Science Foundation (NSF)/Division of Science Resources Statistics (SRS).

Infrastructure: State and local government expenditure on infrastructure (as a share of GDP), including spending on highway and air transportation, housing, water, and sanitation, from Sorens, Muedini, and Ruger (2008).

Tax burden: Tax burden is state and local revenues from all taxes (but not current charges), as a percentage of personal income, from Sorens, Muedini, and Ruger (2008).

Tax structure: Own-source revenue is defined as total government revenue from own source, as a percentage of GDP, from EFNA (2013).

Government size score: The score covering three indicators (all in percent of GDP)—general consumption expenditures by government, transfers and subsidies, and social security payments—is from EFNA (2013).

Poverty rate: Percentage of state population in poverty from Sorens, Muedini, and Ruger (2008).

Financial sector share: Financial sector specialization is assessed as the share of "Finance and Insurance" industry (NAICS code 52) in total private industries in a given state *s* relative to the same share for the U.S. as a whole. For the construction of the synthetic index, see above.

Figure A1. Average TFP Growth Across U.S. States
(Percentage change)
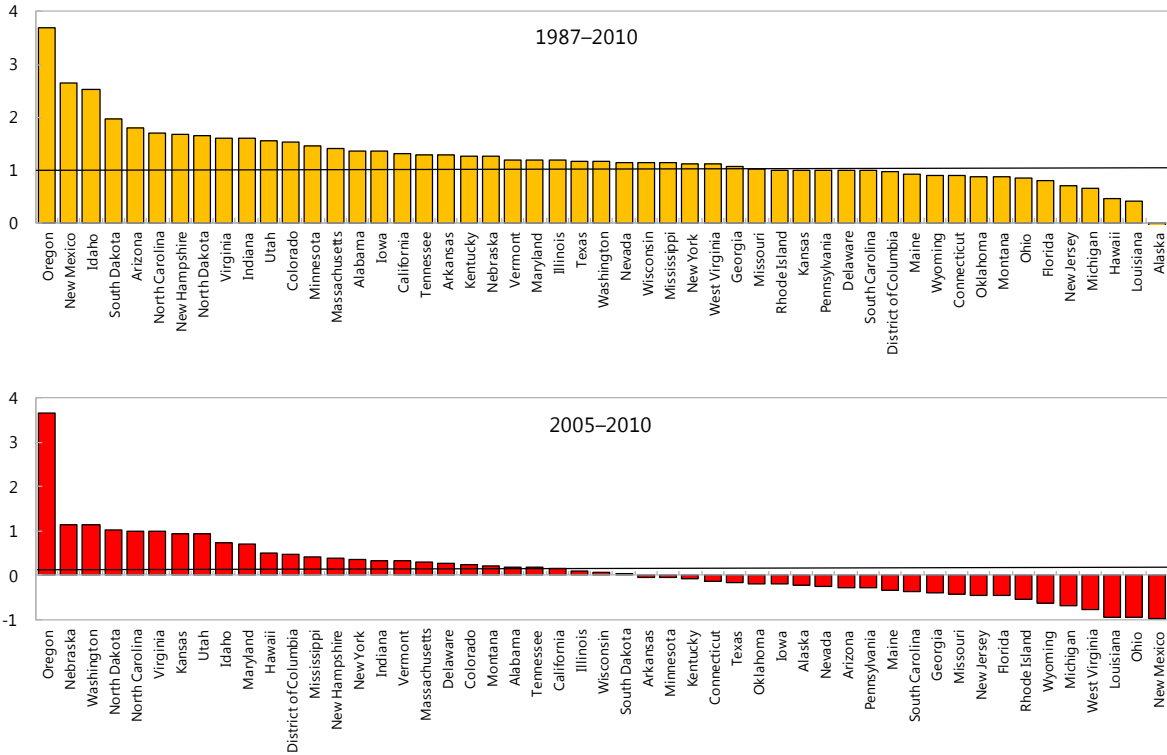
Source: IMF staff estimates.

Figure A2. TFP and GDP Growth: The Case of Oregon

Change in Average TFP Growth Across U.S. States
(Percentage change)

Contribution to GDP Growth: Oregon vs. U.S.
(Percentage change)
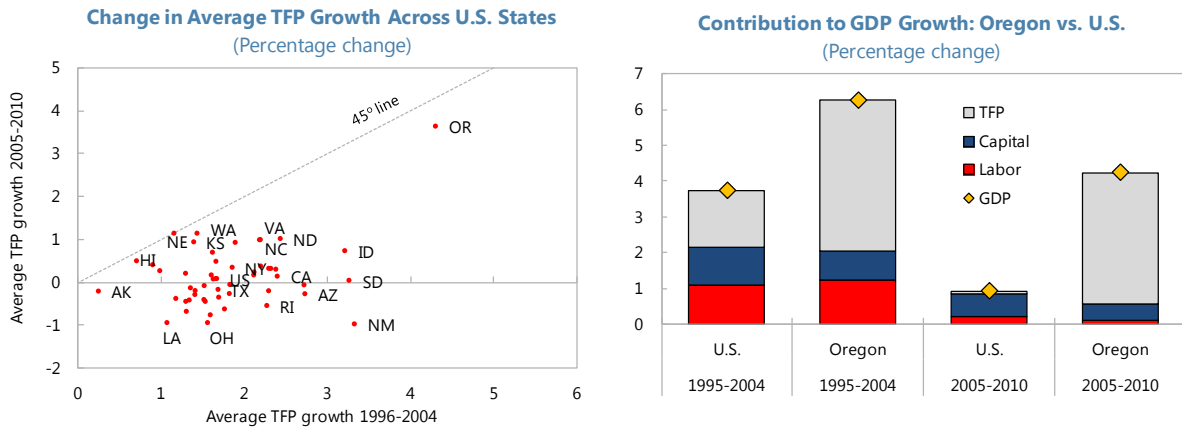
Source: IMF staff estimates.

Figure A3. Average Technical Efficiency, 1996–2010

Technical efficiency estimates derived from a time-varying inefficiency model with convergence:

- one-factor model, $\tilde{y}_{st} = \beta_0 + \beta_{K/L}\tilde{x}_{K/L,st} + \beta_t t + v_{st} - u_{st}$, with per-worker output and capital
- two-factor model, $y_{st} = \beta_0 + \beta_L x_{L,st} + \beta_K x_{K,st} + \beta_t t + v_{st} - u_{st}$
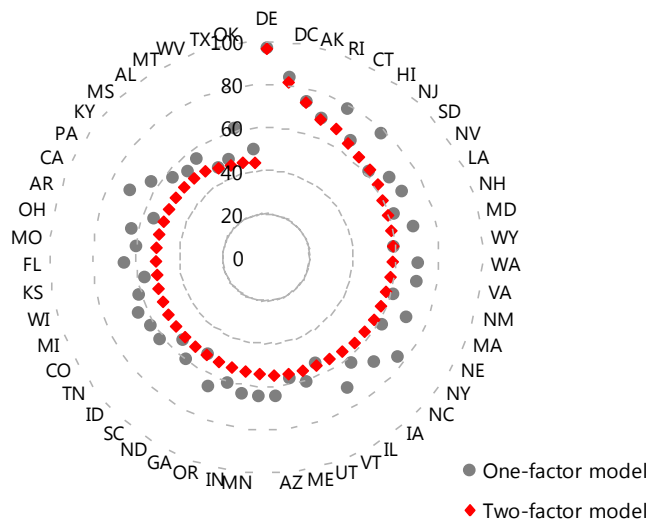
Source: IMF staff estimates.

Appendix 2. Empirical Results and Robustness Analysis

Table A1. Dummy Variable Tests of Post-2005 TFP Slowdown
(Dependent variable: log change in TFP)

$$dlnTFP_{s,t} = \alpha + \beta D + \varepsilon_{s,t} \text{ , where } D=\{1 \text{ if year} \geq 2005; 0 \text{ otherwise}\}$$

Tests of whether deceleration in TFP growth was stronger in IT-producing than non-IT-producing states.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-2005 dummy	-1.70***	-1.77***	-1.73***	-1.74***	-1.55***	-1.89***	-1.64***	-1.70***
	(-10.08)	(-8.17)	(-7.90)	(-7.90)	(-6.67)	(-4.12)	(-6.66)	(-4.18)
Constant	1.83***	1.84***						
	(19.56)	(18.09)						
Weighted least squares		yes	yes	yes	yes	yes	yes	yes
State fixed effects		yes	yes	yes	yes	yes	yes	yes
Oregon excluded				yes				
Excluding IT-producing states					yes			
Only IT-producing states						yes		
Excluding ICT-producing states							yes	
Only ICT-producing states								yes
Observations	765	765	765	750	570	195	525	240
R-squared	0.13	0.16	0.38	0.37	0.31	0.46	0.30	0.45

Notes: Robust *t*-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A2. Tests of Post-2005 TFP Slowdown for IT-Intensive States
(Dependent variable: log change in TFP)

$$dlnTFP_{s,t} = \alpha + \beta D + \gamma IT_s + \delta D \cdot IT_s + \varepsilon_{s,t} \text{ ,where } D=\{1 \text{ if year} \geq 2005; 0 \text{ otherwise}\} \text{ and}$$
$$IT_s \text{ is a } \{0,1\} \text{ dummy variable or a continuous IT-intensity index}$$

Tests of whether TFP growth in IT-intensive states has decelerated more than in non-IT-intensive states.

	(1)	(2)	(3)	(4)
Post-2005 dummy	-2.12	-1.53	-1.73***	-1.63***
	(-0.69)	(-0.50)	(-4.89)	(-4.58)
IT-intensive index	-1.48			
	(-1.06)			
Post-2005 dummy x IT-intensive index	0.35	-0.20		
	(0.11)	(-0.07)		
IT-intensive dummy			-0.30	
			(-1.47)	
Post-2005 dummy x IT-intensive dummy			-0.09	-0.20
			(-0.21)	(-0.45)
Constant	3.32**		2.00***	
	(2.33)		(11.40)	
Weighted least squares	yes	yes	yes	yes
State fixed effects		yes		yes
Observations	765	765	765	765
R-squared	0.17	0.38	0.17	0.38

Notes: Robust *t*-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Results remain robust to alternative (but potentially outdated) measures of IT-intensity summarized in Daveri and Mascotto (2006).

Table A3. Stochastic Frontier Analysis
(Dependent variable: log real GDP)

$$y_{st} = \beta_0 + \beta_L x_{L,st} + \beta_K x_{K,st} + \beta_t t + v_{st} - u_{st}$$

Time-varying inefficiency model with convergence

	1995-04 (1)	1996-05 (2)	1997-06 (3)	1998-07 (4)	1999-08 (5)	2000-09 (6)	2001-10 (7)	2002-10 (8)	2003-10 (9)	1990-10 (10)	1996-10 (11)
Log labor	0.57***	0.60***	0.61***	0.60***	0.60***	0.61***	0.61***	0.63***	0.62***	0.62***	0.60***
	(14.42)	(14.72)	(14.98)	(14.71)	(13.97)	(13.59)	(12.52)	(12.07)	(11.17)	(21.82)	(16.11)
Log capital	0.48***	0.45***	0.45***	0.47***	0.47***	0.47***	0.47***	0.45***	0.45***	0.45***	0.49***
	(13.60)	(12.08)	(11.69)	(11.90)	(11.33)	(11.64)	(10.95)	(9.93)	(9.29)	(18.15)	(14.72)
Time trend	0.01	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.00	0.01***
	(1.55)	(3.57)	(6.51)	(6.02)	(4.27)	(2.75)	(3.74)	(3.37)	(2.70)	(0.92)	(6.97)
Constant	6.06***	6.36***	6.36***	6.20***	6.24***	6.21***	6.27***	6.49***	6.52***	6.40***	5.95***
	(12.56)	(12.92)	(12.95)	(12.21)	(12.18)	(11.95)	(11.61)	(11.49)	(10.94)	(15.00)	(13.24)
Eta	0.02***	0.01***	0.00	-0.01*	-0.01**	-0.01***	-0.01***	-0.01***	-0.01***	0.01***	-0.00
	(5.38)	(2.69)	(0.37)	(-1.65)	(-2.16)	(-3.74)	(-3.33)	(-3.86)	(-3.39)	(7.13)	(-1.41)
Observations	510	510	510	510	510	510	510	459	408	1,071	765
Number of states	51	51	51	51	51	51	51	51	51	51	51

Notes: *z*-statistics in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Eta=decay parameter (see Box 1). Regressions include time fixed effects. See Appendix 1 for the definitions and sources of variables.

Table A4. Stochastic Frontier Analysis with Conditional Inefficiency Effects
(Dependent variable: log real GDP)

$$y_{st} = \beta_0 + \beta_L x_{L,st} + \beta_K x_{K,st} + \beta_t t + v_{st} - u_{st}, \text{ with}$$

$u_{st} = z_{st}\delta + w_{st}$ where z_{st} is a vector of explanatory variables associated with technical inefficiency of production in state s

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Frontier							
Log labor	0.44***	0.43***	0.50***	0.43***	0.43***	0.43***	0.40***
	(23.01)	(22.74)	(19.85)	(23.04)	(21.13)	(22.07)	(22.59)
Log capital	0.60***	0.61***	0.51***	0.61***	0.60***	0.62***	0.63***
	(32.21)	(33.00)	(20.57)	(33.26)	(30.03)	(32.09)	(36.59)
Time trend	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.005***
	(6.83)	(8.74)	(3.40)	(8.98)	(8.20)	(11.11)	(4.06)
Constant	4.55***	4.42***	5.48***	4.41***	4.49***	3.99***	4.27***
	(15.08)	(12.50)	(18.48)	(17.53)	(10.85)	(18.09)	(19.83)
Mean inefficiency							
Schooling	-0.12***	-0.11***		-0.11***	-0.09***	-0.05***	
	(-15.57)	(-15.35)		(-14.43)	(-10.59)	(-3.71)	
Log schooling							-0.71***
							(-7.69)
GR dummy		0.07***	0.05***	0.08***	0.07***	0.06***	0.05***
		(5.37)	(3.02)	(5.50)	(5.45)	(3.99)	(4.09)
Tertiary educ.att.			-0.01***				
			(-12.60)				
Elementary educ.att.			-0.01***				
			(-4.47)				
Gov R&D spending				-0.02***			
				(-4.43)			
Total R&D spending					-0.02***		-0.01***
					(-5.51)		(-6.18)
Poverty rate						0.01***	
						(7.32)	
Financial sector share							-1.37***
							(-20.72)
Constant	1.97***	1.92***	0.83***	1.84***	1.57***	0.58***	2.47***
	(8.72)	(6.57)	(13.31)	(11.50)	(4.45)	(3.05)	(9.72)
Observations	1,071	1,071	561	1,071	856	900	714
Number of states	51	51	51	51	51	50	51

Notes: z-statistics in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$. GR dummy is the Great Recession dummy variable (=1, if year>2007; 0 otherwise). See Appendix 1 for the definitions and sources of variables.

Table A5. Determinants of Total Factor Productivity

	Fixed-Effects Estimator				Mean Group Estimator			
	Dependent variable: TFP growth				*Dependent variable: log TFP*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Schooling	0.42**							
	(2.02)							
Log schooling			5.50**	9.64***	5.00***	5.15***	4.71***	3.91***
			(1.98)	(2.69)	(4.23)	(4.02)	(4.23)	(2.94)
Tertiary educational attainment		0.16*						
		(1.70)						
Business R&D expenditure	0.36**		0.08	7.45*				
	(2.48)		(0.48)	(1.83)				
Total R&D expenditure		0.40*						
		(1.69)						
Government R&D expenditure			-0.52***	-0.48***	0.26	0.61***	0.53**	0.50**
			(-2.86)	(-2.64)	(1.15)	(2.61)	(2.55)	(2.50)
Business x Gov. R&D expenditure			0.36**	0.38**				
			(2.01)	(2.16)				
Log schooling x Business R&D exp.				-2.83*				
				(-1.81)				
Time trend					-0.02***	-0.02***	-0.02***	-0.01**
					(-3.96)	(-3.62)	(-3.77)	(-2.26)
Own-source taxes (% GDP)						2.04***	1.97***	0.77
						(3.41)	(3.35)	(1.29)
Tax burden (% GDP)						-6.38***	-6.31***	-4.46**
						(-3.11)	(-3.11)	(-2.23)
Capital expenditure (% GDP)							-0.01	
							(-0.28)	
Government size score								0.04*
								(1.65)
Constant	-4.49	-3.76	-12.75*	-23.50**	-5.68*	-5.86*	-4.65*	-3.38
	(-1.65)	(-1.39)	(-1.78)	(-2.53)	(-1.92)	(-1.83)	(-1.69)	(-0.99)
Combined effect (for interaction terms)								
Log schooling				5.68**				
				(2.05)				
Government R&D expenditure			-0.02	0.06				
			(0.08)	(0.28)				
Business R&D expenditure			0.25	0.21				
			(1.57)	(1.34)				
Time fixed effects	yes	yes	yes	yes				
State-specific time trend					yes	yes	yes	yes
Three-year averages	yes	yes	yes	yes				
Annual					yes	yes	yes	yes
Observations	346	204	346	346	1,071	950	950	950
R-squared	0.40	0.48	0.42	0.42				
Number of states	51	51	51	51	51	50	50	50

Notes: *t*-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1. See Appendix 1 for the definitions and sources of variables.

MONETARY POLICY COMMUNICATION AND FORWARD GUIDANCE[25]

A. Introduction

57.   **Forward guidance has taken a more important role during the Global Financial Crisis (GFC) and its aftermath.** Already prior to the crisis, some central banks used explicit forward looking language as a device to increase transparency and strengthen the effectiveness of monetary policy. However, with the onslaught of the GFC, a growing number of central banks, including the U.S. Federal Reserve (the Fed), began to use forward guidance as a way to provide greater clarity about their policy intentions and reaction function.[26]

58.   **The Fed has used forward guidance to add stimulus and reduce uncertainty about future policy**.[27] Whether forward guidance can achieve these objectives depends on whether it is perceived as credible and whether it can enhance policy predictability through systematic and clear communication.[28] In normal times, both credibility and predictability are helped by a well established pattern of past policy behavior that has proven successful in achieving the central bank's stated policy objectives. However, as argued by Woodford (2012), in unusual circumstances, when policymakers have to break from past behavior, forward guidance becomes particularly challenging and requires more explicit explanations to be effective. Indeed, since December 2008, the Fed has taken several steps to clarify its goals and policy strategy, and to provide information about the expected path for policy rates (see Box 1).

59.   **Assessing the effectiveness of forward guidance requires distinguishing between shifts in the behavior of monetary policy and in the economic outlook**. A forward guidance announcement associated with a more protracted policy rate path can be interpreted as a signal of either (i) a weaker economic outlook and/or lower inflation, or (ii) a more accommodative policy stance given current and projected economic conditions. Both would lead to lower expected interest rates. Similarly, lower policy rate uncertainty could reflect clearer and more systematic Fed communication or reduced uncertainty about the economic outlook.

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[25] Prepared By Tim Mahedy, Jarkko Turunen and Niklas Westelius.

[26] The Fed also had some experience with forward guidance prior to the crisis. For instance in August 2003, the FOMC stated that it believed that policy accommodation could be maintained for a "considerable period".

[27] See Bernanke (2013).

[28] Credibility requires consistency between forward guidance and the central bank's policy objectives (e.g., price stability and maximum employment) as well as with its economic outlook. Predictability requires that the public understands how the central bank adjust its projected policy path as underlying economic data changes.

Box 1. The Fed's Communication since 2008

Communication channels. In March 2011, the FOMC introduced regular post-meeting press conferences by the chairman. The press conferences coincide with the committee's publication of the Summary of Economic Projections (SEP) and are intended to "further enhance the clarity and timeliness of the Federal Reserve's monetary policy communication."

Policy objectives and strategy. In January 2012, the FOMC published a statement on its longer-run goals and monetary policy strategy, formally committing to a 2 percent inflation target and assessment of maximum employment based on a range of indicators. The statement also clarified that the FOMC follows a balanced approach in making tradeoffs between the two objectives when necessary.

Forward guidance. In January 2012, the FOMC included federal funds rate projections by FOMC participants in the SEP (the so-called "dot" graph). Since December 2008, the FOMC has gone through four different forward guidance regimes:

- *Qualitative FG I*: In December 2008, together with establishing a target range for the federal funds rate of 0 to 1/4 percent, the FOMC introduced qualitative policy rate guidance by indicating that economic conditions are likely to *"warrant exceptionally low levels of the federal funds rate for some time."* In March 2009 the language was changed to *"for an extended period."*

- *Date based FG*: In August 2011, the FOMC shifted to date-based guidance by declaring that economic conditions are likely to *"warrant exceptionally low levels of the federal funds rate at least through mid-2013"*. In January 2012, the date was changed to late 2014, and in September 2012, it was changed to mid-2015.

- *State based FG*: In December 2012, the FOMC transitioned to state-based guidance by stating that the committee deemed it appropriate for the federal funds rate to be at its zero lower bound at *"least as"* long as unemployment remains above 6.5 percent, projected inflation is no more than 2.5 percent and longer term inflation expectations are well anchored. This announcement also coincided with an extension of the long-term asset purchase program. In December 2013 the language was changed from *"at least"* to *"well past."*

- *Qualitative FG II*: Finally, in March 2014, the FOMC went back to qualitative guidance by removing the reference to specific unemployment and inflation thresholds. Instead the committee stated that it would be *"appropriate to maintain the current target range for the federal funds rate for a considerable time after the asset purchase program ends, especially if projected inflation continues to run below the Committee's 2 percent longer-run goal."* and that it *"anticipates that, even after employment and inflation are near mandate-consistent levels, economic conditions may, for some time, warrant keeping the target federal funds rate below levels the Committee views as normal in the longer run."*

60.   **This selected issues paper addresses two main questions.** First, did forward guidance represent a shift in the reaction function of the Fed or simply signal a weaker economic outlook? Second, did forward guidance move policy rate expectations as

intended and reduce policy uncertainty? To complement existing studies, we focus on the impact of the different forward guidance regimes on policy uncertainty.[29]

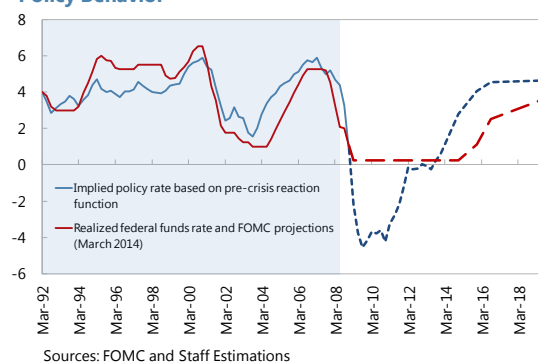## B.   Did Forward Guidance Represent a Change in the Fed's Reaction Function?

61.   **Monetary policy before the crisis is well proxied by an estimated reaction function over inflation and unemployment**. Given the Fed's dual mandate of price stability and maximum employment a simple pre-crisis reaction function was estimated by regressing the federal funds rate (ff) on core PCE inflation (π) and the unemployment gap (u^g).[30]

$$ff_t = 0.86 + 1.82\,\pi_t + 1.58\,u_t^g \qquad\qquad R^2 = 0.77$$

$$(0.34)\quad(0.13)\quad(0.15)$$

Although the overall fit of the regression is quite high, there are two past periods where the implied policy path persistently differs from the actual (see Figure 1). The later episode, which occurred in the mid 2000s and where the predicted path was higher than the realized path, is particularly noteworthy as it coincided with the Fed's first experiment with explicit forward guidance (i.e., August 2003 to December 2005).[31] Figure 1 also shows the implied policy rate path over the medium term based on the latest FOMC projection (June 2014). The large deviation between the implied path (dashed blue) and that of the committee's median projection (dashed red) suggests a marked break from pre-crisis behavior.

Figure 1. Forward Guidance Compared to Pre-crisis Policy Behavior

Implied policy rate based on pre-crisis reaction function

Realized federal funds rate and FOMC projections (March 2014)

Sources: FOMC and Staff Estimations

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[29] This paper does not tackle other important communication issues, such as how to communicate about financial stability considerations, the future of the Fed balance sheet or operational framework (see also S. Gray and D. King "The Operational Framework for Monetary Policy", Selected Issues Paper, 2014).

[30] The OLS regression was estimated using quarterly data over the sample period 1985:Q1 and 2008:Q3, and the unemployment gap is defined as the difference between the unemployment rate and CBO's estimate of the NAIRU. The numbers in parentheses are the standard errors of the estimated coefficient, indicating that they are all statistically significant at the 5 percent level. Moreover, the estimated reaction function suggests that the Fed raise the real interest rate in response to inflationary pressure (consistent with the Taylor principle) and that the long-run federal funds rate is approximately 4.5 percent, given an inflation target of 2 percent.

[31] The first period in the 1990s has been attributed by some observers to a temporary hike in the neutral rate due to strong productivity growth as well as by the Fed's policy of opportunistic disinflation. The explicit forward guidance in August 2005 was in response to concerns that the policy rate would hit the ZLB.

62.   **Starting from 2012, the FOMC members' projected policy path deviates significantly from pre-crisis behavior, suggesting a shift in the Fed's reaction function.** In early 2012, the implied path of the federal funds rate based on pre-crisis behavior and the median of FOMC member's projected policy rate path were fairly well in line with each other. [32] However, while the implied policy path shifted up during 2012, due to a slight improvement in the FOMC's economic outlook, the median projected path was lowered and the lift-off date pushed further out (see Figure 2 and Table 1). Indeed, some FOMC members explicitly stated that the shift to date-based guidance did not constitute a more pessimistic view on the US economic outlook. [33]

Figure 2. A Shift to an Expansionary Stance Despite an Improving Economic Outlook, 2012
(September, 2012)
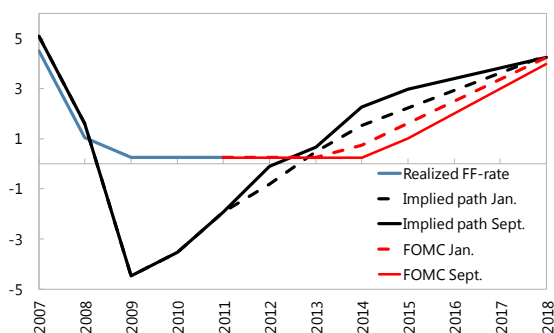
Table 1. FOMC's Economic Outlook and Policy Projections for 2014

Projections	Date of Projection		
	Jan-12	Jun-12	Sep-12
Unemployment rate	7.2	7.4	7.0
PCE core inflation	1.8	1.8	1.9
Federal funds rate	0.75	0.50	0.25

Source: Selected Economic Projections, FOMC. The numbers correspond to the mid point of the central tendancy for each variable.

63.   **Alternatively, the shift in the FOMC member's projected path could potentially be explained by unusual headwinds from the crisis.** The shift to a more protracted policy rate path could also reflect a focus on broader measures of slack or a lower neutral real rate. [34]

- *Greater labor market slack than indicated by headline unemployment (or concerns that inflation was likely to run below target).* The crisis has been associated with a greater decline in labor force participation than can be explained by demographic factors, as well as a rising number of part-time employed. [35]

- *A lower neutral real policy rate.* Shifts in savings preferences, lower expected future growth, as well as global conditions could have contributed to a decline in the neutral

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[32] The implied path is derived using the midpoint of unemployment and inflation from the SEP.
[33] See Dudley (2012) and Bullard (2013).
[34] See also Levin (2014).
[35] See Balakrishnan et al. (2014).

real interest rate. For example, estimates by Laubach and Williams (2001) suggest a current real neutral federal funds rate that is close to zero.

64.   **Empirical evidence suggests that markets interpreted date-based forward guidance as a shift in the reaction function, and not as a deterioration in the economic outlook.** Femia et al. (2013) use primary dealer survey data to show that date based forward guidance coincided with a perceived shift to a more accommodative monetary stance. Similarly, Raskin (2013) provides evidence of a shift in the Fed's reaction function by showing that interest rate expectations became significantly less sensitive to macroeconomic surprises after the introduction of date-based forward guidance.[36]

65.   **Event studies have also found that forward guidance moved expectations in the intended direction.** By defining a narrow window around FOMC announcements, event studies are designed to exclude other factors that might influence expectations such as news about the economic outlook. Campbell et al. (2012) and Femia et al. (2013) find significant announcement effects that lowered expected short term rates, as well as rates on longer term Treasuries and corporate bonds. Woodford (2012) shows that announcements had significant intra-day effects lowering interest rates and contributing to a flatter yield curve.

66.   **However, market responses also appear to have differed across forward guidance regimes**. First, while the initial introduction of qualitative guidance in December 2008 and the date based guidance in August 2011 had sizable negative impacts on policy rate expectations, the shift to state based guidance in December 2012 had virtually no impact on policy rate expectations (see Figure 3). The latter result may reflect the fact that market participants had anticipated the shift, but it is also in line with the FOMC statement that made it clear that the FOMC viewed the new forward guidance

Figure 3. Interest Rate Impact on Forward Guidance Announcement Days 1/
(Daily change in the expected rate, percent)
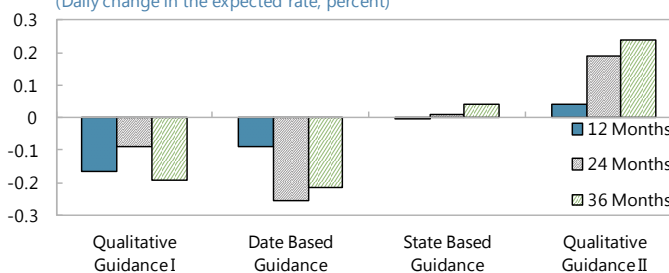
1/ Daily change in the interest rate of Eurodollar futures.
Sources: Bloomberg and staff estimates.

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[36] Swanson and Williams (2013) also find that the sensitivity of short rates to macro news declined during the qualitative and date based forward guidance periods, suggesting that they were effective in anchoring rate expectations.

as consistent with its earlier date-based guidance. Second, the shift back to qualitative guidance in March 2014 coincided with an increase in policy rate expectations at announcement. However, this shift may also reflect an upward revision in FOMC member's projections for policy interest rates that were released at the same time.[37]

C. Did Forward Guidance Reduce Policy Uncertainty?

67.   **Forward guidance has been associated with a decline in policy uncertainty**. While most of the recent literature has focused market expectations about interest rates, less attention has been paid to the impact of forward guidance on policy rate uncertainty. Bauer (2012) finds that early announcements of forward guidance reduced uncertainty about future interest rates. Filardo and Hoffman (2014) show descriptive evidence that forward guidance has coincided with lower interest rate uncertainty at shorter horizons. Indeed, implied volatility of swaptions (a measure of interest rate uncertainty) has

Figure 5. Time to Liftoff
(Years)

Source: Bloomberg and staff estimates.

declined during the forward guidance period, with some increase in volatility at longer horizons from mid-2013 onwards (see Figure 4). The period of date based forward guidance in particular coincides with a sizeable decline in uncertainty. At the same time, the introduction of date based forward guidance resulted in a significant increase in market expectations about the time to lift-off from the ZLB (see Figure 5). While time to lift-off is also impacted by changes in the economic outlook, the upward shift at the announcement of date based guidance suggests that a significant part of the dampening impact of forward guidance on rate uncertainty worked through this channel. The period with state based forward guidance coincides with some increase in volatility at longer horizons and, as the recovery proceeded, a decline in the expected distance to lift-off. Finally, the return to qualitative forward guidance has been associated with an increase in policy uncertainty.

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[37] More generally, interpretation of specific events is complicated by announcements that occurred at the same time. For example, the introduction of date based forward guidance coincided with an extension of the LSAP program.

Figure 4. Implied Volatilities of Swaptions

Sources: Bloomberg and staff estimates.
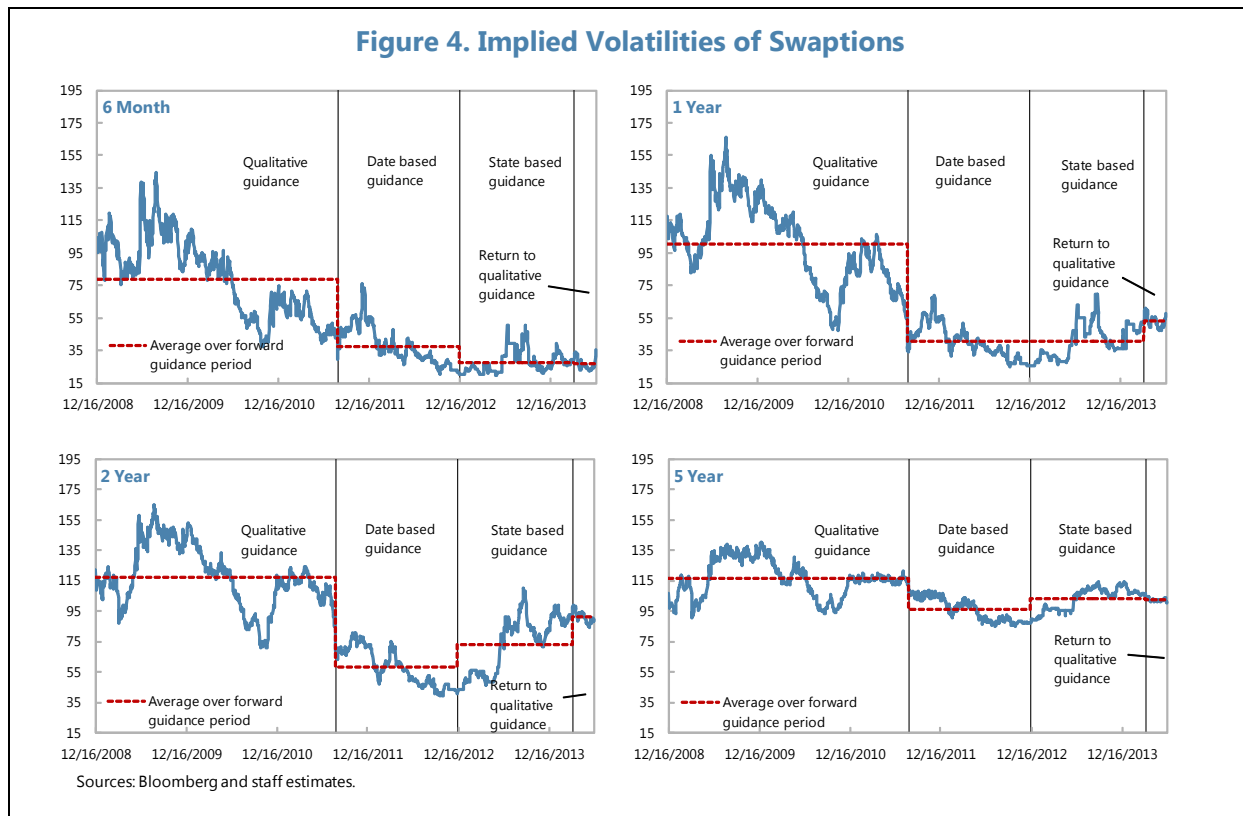
68.   **Uncertainty about the economic outlook has also fallen.** Lower policy uncertainty could reflect less uncertainty about the near-term economic outlook. Forecaster disagreement about both inflation and the unemployment rate (as measured by the dispersion in private sector forecasts four quarters ahead) have also declined over time (see Figure 6). This is true in particular for the period after date based forward guidance was announced.

69.   **Regression evidence.** To futher analyze the impact of forward guidance on uncertainty, we regress measures of uncertainty on future interest rates on indicator variables for the forward guidance periods, controlling for economic uncertainty and other factors (including broader market uncertainty and risk aversion as proxied by the VIX

Figure 6. CPI and Unemployment Rate 1/
(Percent)

1/ Measurement of dispersion, or the difference in forecasts between the 75th and 25th percentiles.
Source: Philidelphia Federal Reserve.

index) (see the Appendix for a more detailed description of the data). Specifically, we estimate OLS regressions:
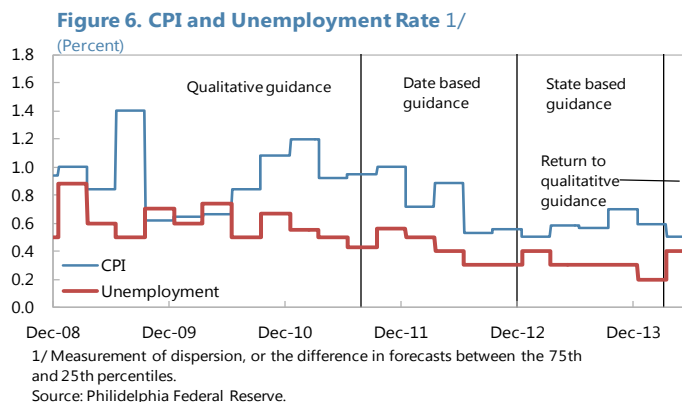
$$VOL_t = \alpha + \beta ECON_t + \sum_{i=1}^{3} \lambda_i FG_i + X_t + u_t$$

Where *VOL* is a measure of uncertainty about future interest rates (implied volatility of swaptions at different time horizons); *ECON* a measure of economic uncertainty (forecaster disagreement on unemployment and inflation) and FG are step dummy variables for the three forward guidance regimes (with the first qualitative forward guidance period as the omitted category). We also include control variables *X* (VIX, time to lift off from the ZLB and the OIS-Libor spread). The regressions were estimated using daily data over the sample period from 12/16/2008 through 06/16/2014.

70.   **Regressions evidence confirms that forward guidance was associated with lower policy uncertainty, with some differences across regimes**. Several interesting results emerge:

- *Economic uncertainty increases uncertainty about future policy interest rates*. As expected, msot coefficients for forecaster disagreement about the unemployment rate and inflation are positive and statistically significant (see Table 2). Broader market uncertainty (as measured by the VIX) is also associated with higher uncertainty about future policy interest rates.

- *Date-based forward guidance is associated with lower policy rate uncertainty on average*. This effect is primarily driven by date-based forward guidance successfully pushing the lift-off date further out, and therefore providing greater clarity about the period when policy rates were expected to remain close to zero (see Figure 7).

- *State-based forward guidance may have reduced policy uncertainty above and beyond time to-lift-off.* In particular, there is some evidence that once time to lift-off is controlled for, state-based forward guidance was associated with lower policy uncertainty. This may reflect the fact that at shorter horizons, state based forward guidance provided a more systematic approach to evaluating progress towards liftoff from ZLB. Indeed, this seems to be consistent with Bernanke's (2013) argument that an important limitation to date based guidance was that it did not explain how future policy would be affected by changes in the economic outlook.

- *While based on a short sample, there is some evidence that the return to qualitative forward guidance was associated with lower uncertainty.* Despite the increase in uncertainty at announcement, the regression evidence suggests that qualitatitive forward guidance has been associated with lower uncertainty. This may reflect additional forward guidance about the path of policy rates post lift-off.

Table 2. Regressions Results

Regression Results - Implied Volatility of Swaptions

	1 Year Expiry, 1 Year Tenor	2 Year Expiry, 1 Year Tenor
SPF CPI Forecast	8.811*	17.83***
SPF Unemployment Forecast	19.52***	3.526
VIX	0.680***	0.713***
FG 2	-53.01***	-53.41***
FG 3	7.337***	20.38***
FG4	8.622***	19.06***
LIBOR OIS-Spread	-0.128***	-0.246***
Constant	67.32***	88.17***
R-sq	0.727	0.707
Observations	1357	1358

Regression Results - Implied Volatility of Swaptions w/ Time to Liftoff

	1 Year Expiry, 1 Year Tenor	2 Year Expiry, 1 Year Tenor
SPF CPI Forecast	1.224	9.916***
SPF Unemployment Forecast	4.029	-12.75***
VIX	0.369***	0.387***
Time to Liftoff	-3.828***	-4.017***
FG 2	14.84***	17.80***
FG 3	-23.19***	-11.64***
FG4	-17.49***	-8.329***
LIBOR OIS-Spread	-0.173***	-0.293***
Constant	139.3***	163.7***
R-sq	0.895	0.938
Observations	1357	1358

Figure 7. Cumulative Effects of Foward Guidance on Interest Rate Volatility, Swaption 1y 1y
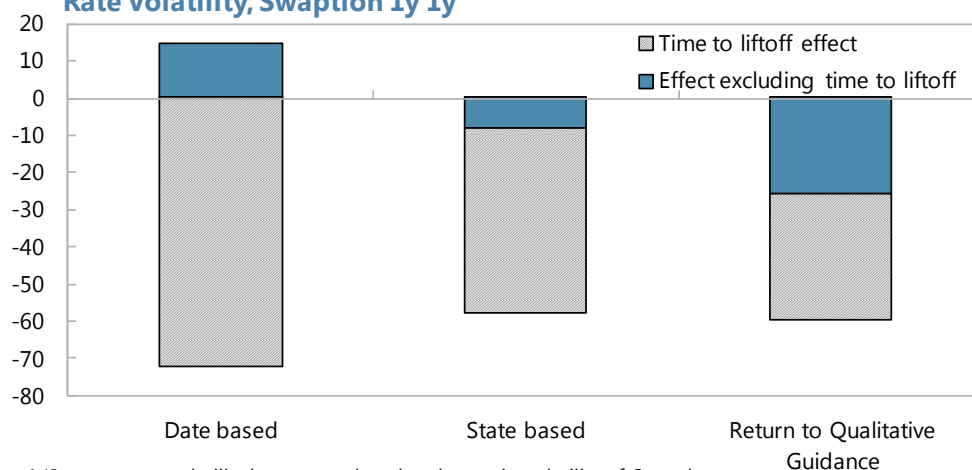
1/ Interest rate volatility is measured as the change in volatility of Swaptions with a 1 year expiry and 1 year tenor.
Sources: Bloomberg and staff estimates.

71.   **These regression results are subject to a number of caveats.** The descriptive regressions do not identify causal effects and estimated impacts could reflect omitted factors. Furthermore, the analysis of volatility is complicated by the ZLB which tends to shrink volatility. However, the qualitative results for the forward guidance periods are robust across a number of alternative specifications, such as using alternative measures of uncertainty (e.g. realized volatility of eurodollar futures or the MOVE index of implied volatility in Treasuries), other variables to capture economic uncertainty (e.g. the Citi surprise index), and controlling for other factors (e.g. the impact of euro area sovereign stress using the spread between euro area core versus perphery bonds). To minimize complication from the ZLB the analysis refrains from comparisons with non-ZLB periods.

D.   Conclusions

72.   **Uncertainties remain whether the deviation from pre-crisis policy is due to a change in the Fed's reaction function or lingering headwinds from the crisis.** Empirical evidence suggests that market participants have interpreted the protracted policy path as a shift in the Fed's reaction function and not as response to a deteriorating outlook. While the Fed has mentioned a number of reasons for the protracted path, there have been calls for more

clarity from both within the FOMC and from market participants. [38] Further communication about the FOMCs consensus view on the rationale for the protracted policy path could facilitate a smoother and more predictable normalization process.

73.   **Forward guidance has generally been effective in moving policy expectations in the intended direction and in reducing policy uncertainty**. This is consistent with the Fed's stated objectives of forward guidance policy. However, recent events have also resulted in challenges, in particular as the economic recovery has been moving the Fed closer towards a turning point in monetary policy.

74.   **Across regimes, there is some evidence that more recent forward guidance was been more effective in guiding expectations and reducing uncertainty than initial qualitative forward guidance**. This experience suggests a potential trade off between systematic communication and policy flexibility. More recently, there is some evidence that the recent shift back to qualitative forward guidance was associated with lower uncertainty, perhaps reflecting additional guidance about the path of policy rates post lift-off. Looking forward , while qualitative forward guidance will provide the FOMC with more policy flexibility, it also suggests a greater premium on clear and systematic communcation to avoid an increase in policy uncertainty as lift-off approaches.

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[38] See Bernanke (2012) for a list of reasons for the protracted path and Plosser (2014) and the NY Federal Reserve Survey of Primary Dealers for calls for more clarity.

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Appendix 1. Data Description

Implied volatility of swaptions. A swaption is an option that gives one party the right, but not the obligation, to swap a fixed rate for a floating rate (based on the 3 month Libor). The expiry of the option denotes the amount of time the party has to exercise the option, while the option tenor is the duration of the contract once it's exercised. The expiry can be thought of as an approximation of the interest rate horizon. For instance, an option with a 1 year expiry, 1 year tenor, represents market sentiment about the short-term rate over a year, one year from now.[39]

The dispersion of forecasts. The dispersion of the Philadelphia Federal Reserves' Survey of Professional Forecasters (SPF) forecasts is the difference between the 75th and 25th percentiles of private market participants four quarters ahead forecast of the CPI and the unemployment rate.

Time to lift-off. We construct a 36-month ahead curve from generic monthly Federal Funds futures contracts for each day and count the number of months until the interest rate exceeds 50 basis points.

VIX. Measure of the implied volatility of the S&P 500 index options over the next 30 days.

OIS-Libor Spread. Spread between the overnight indexed swap and the 3-month LIBOR rates, a commonly used measure of credit and liquidity risk.

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[39] For robustness, we also run regressions using realized volatility of eurodollar futures, as well as the MOVE index of implied volatility in Treasuries as the dependent variable and other control variables. Realized volatility of Eurodollar futures contracts: Eurodollar futures contracts are derivatives based on the interest rate paid on dollar denominated short-term deposits outside of the United States. The realized volatility is computed as the 10-day standard deviation of the day-over-day rate change based on the end of day option price. Merrill Lynch Option Volatility Expectations Index (MOVE Index): the index is a weighted index of implied volatilities on 1-month Treasury options at different maturities. The weights are: 20% on 2yr, 20% on 5yr, 40% on 10yr, and 20% on 30yr. Realized volatility and the MOVE index show similar trends. We also contolled for euro area sovereign stress using the spread between euro area core versus periphery long term (10 year) bonds.

THE OPERATIONAL FRAMEWORK FOR MONETARY POLICY

E. Introduction

75. **Unconventional policies have been used for a longer period and in greater volume than originally envisaged, with focus now moving toward the Fed's preparedness to manage financial conditions during normalization.** The Fed commenced Large Scale Asset Purchases (LSAPs) in 2009, and has increased its balance sheet from $800 billion to $4.3 trillion. Tapering commenced in early-2014 with the expectation that the LSAP program would gradually be wound down and finish towards the end of 2014, if economic conditions evolve as expected.

76. **The FOMC has indicated that it wants to reduce the size of its balance sheet over time and return to targeting short-term interest rates.** It first outlined its Exit Strategy Principles in June 2011, and suggested that it wanted to return the quantity of bank reserves to *'the smallest levels that would be consistent with the efficient implementation of monetary policy.'*[40] It reviewed its Exit Strategy Principles and normalization plans in May 2013 and April 2014, noting that the Federal funds rate *may not* be the best indicator of the general level of short-term rates, and that new tools may be needed to improve control over short-term rates.[41]

77. **This paper assesses operational issues during normalization and for the longer term.** The pre-crisis framework is described, preparedness for exit is assessed, and suggestions offered on the shape of the post-normalization framework.

F. Some History

The Pre-crisis Framework

78. **Pre-crisis, the Fed targeted the federal funds rate, an overnight unsecured interest rate.**[42] Typically policy announcements had an immediate impact on money market rates, and there was little long-term relationship between excess reserves, which were very small ($1 billion to $2 billion), and trends in interest rates (Figure 1). There was however a tight connection between the level of excess reserves and interest rates within the reserve maintenance period. Excess reserves were low, reflecting a low level of demand given a high opportunity cost (excess reserves were not remunerated) in the context of a well functioning money market and efficient payments infrastructure.

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[40] Minutes of the FOMC meeting held June 2011.
[41] Minutes of the FOMC meetings held April 30–May 1, 2013 and April 29–30, 2014.
[42] Simon Potter: Executive Vice President Federal Reserve Bank of New York, December 2, 2013. Recent Developments in Monetary Policy Implementation: (Potter speech).

79.   **The Fed conducted monetary policy in the context of a small structural liquidity deficit using a standard set of instruments.**[43] The bulk of the deficit came through the Fed's policy of increasing its holdings of U.S. Treasury securities as the stock of Federal Reserve notes rose over time, as well as the imposition of the reserve requirement on depository institutions. In addition, the discount window (rarely used) was available to depository institutions, and fine-tuning open market operations (OMO) to adjust the supply of reserve balances with fluctuations in demand, were conducted on a daily basis with a small set of primary dealers.[44]

Figure 1. Excess Reserves of Depository Institutions and Selected Interest Rates (Monthly average)	Figure 2. Composition of Reserve Requirements (Monthly average)
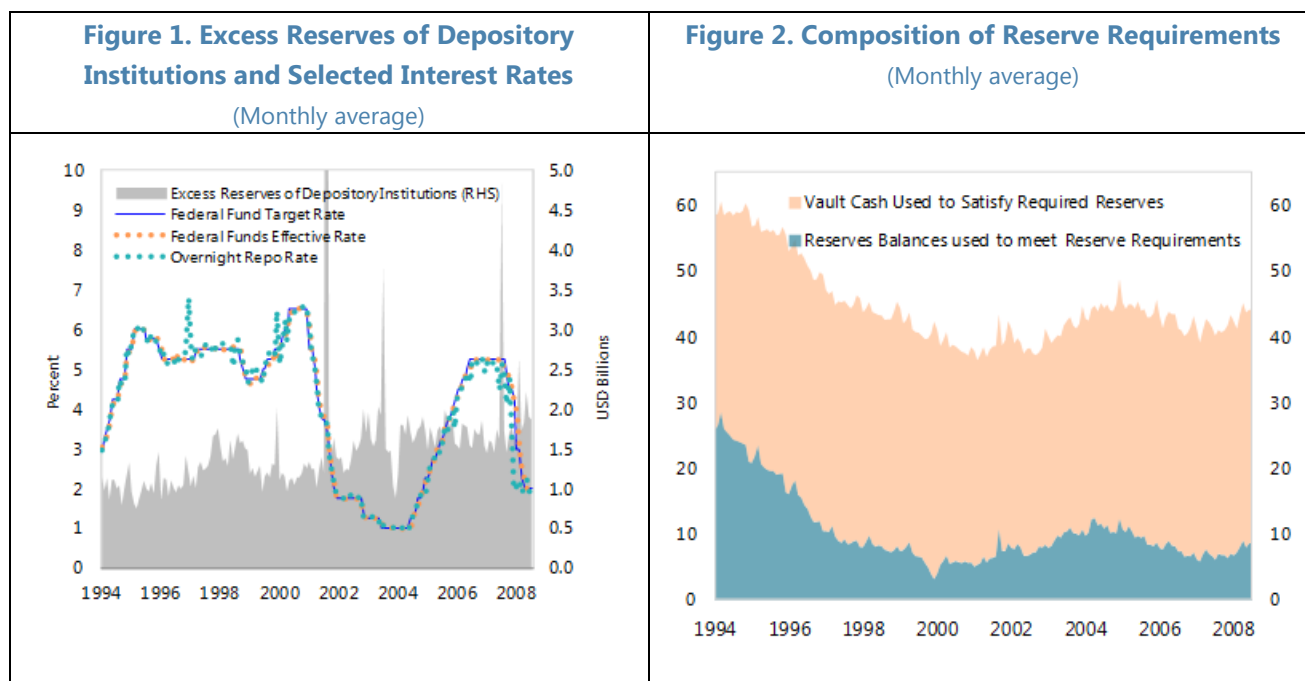
Sources: Federal Reserve Bank of St. Louis and IMF calculations.

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[43] The main features of the monetary policy frameworks of the Bank of Japan, the Federal Reserve and the Eurosystem: Conference paper May 2000.
[44] Primary dealers, usually numbered between 20 and 25, and were required to be a banking organization or a registered securities dealer in good standing with the regulator. Their duties included making markets to the Fed Trading desk, supporting the U.S. Treasuries market, and providing market intelligence.

Post-Lehman Balance Sheet Expansion

80.   **In response to the financial crisis, and in an effort to stabilize financial markets and promote economic recovery, the Fed introduced major changes to its operational framework:**

- To maintain control over short-term money market rates while adding liquidity to counter growing financial stability risks, the Fed started remunerating reserves balances in October 2008, which was earlier than an initially planned date of 2011.[45]

- In December 2008 the fed funds target was changed from a *point target* (1.0 percent) to a *range target* (0–0.25 percent).

- Initially various Fed lending programs and then ongoing LSAP programs significantly increased the volume of excess reserves (Figure 3). The interest rate paid on excess reserves (IOER) has been 0.25 percent for some time, while the expansion in excess reserves put downward pressure on both the fed funds rate and repo rates resulting in both trading below this level.[46] The fed funds rate has generally remained in a range of 0.05 to 0.15 percent in recent years.

81.   **In parallel to those moves, fed funds transactions contracted sharply and with a change in the nature of activity.** Initially, markets fragmented as uncertainty about the health of the banking system led to a flight to quality and less trading between financial institutions. Subsequently, the introduction of the IOER and the increase in excess reserves reduced institutions' need to actively manage liquidity. As a result, fed funds daily activity fell from an estimated $250 billion in 2006 to $60 billion at the end of the 2012. The nature of the lending to the market also changed, with Federal Home Loan Banks (FHLB), that do not have access to the IOER, now estimated to provide 75 percent of fed funds lending, up from a pre-crisis estimate of 40 percent.[47] The other

Figure 3. Reserves of Depository Institutions and Selected Interest Rates

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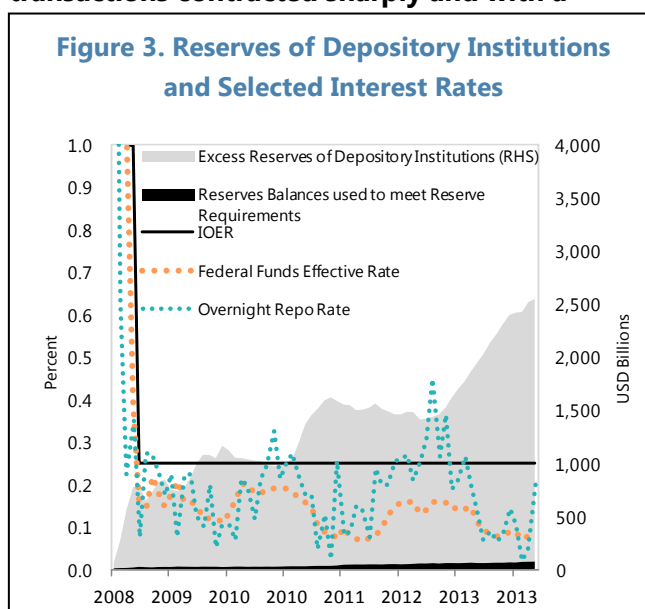
[45] The Financial Services Regulatory Relief Act 2006 authorized the Fed to pay interest on reserves beginning October 2011. This authority was superseded by the Emergency Economic Stabilization Act 2008 bringing forward the authority to October 2008.

[46] The IOER does not act as a firm floor to the Fed Funds rate because only depository institutions have access to the IOER. Government Sponsored Enterprises do not have access to IOER and are large sellers of Fed funds.

[47] Liberty Street Economics December 2, 2013: Who's Lending in the Fed Funds Market?

large entities that do not have access to IOER—Fannie Mae and Freddie Mac—appear not to have been active in the fed funds market since 2011. U.S. branches of foreign banks now represent a bigger share of borrowing in the market. This is attributable in large part to differences in capital requirements and the FDIC's expansion of its deposit insurance assessment base (2011) [48] that increased the effective cost of fed funds for domestic banks and undermined the latter's ability to arbitrage the IOER. Deposits held by U.S. branches of foreign banks are generally not insured.[49] Despite all of these changes, the Fed considers that fed funds rate is still connected to other money market rates and remains a good indicator of banks' marginal funding costs.

G. Normalizing the Policy Stance

The Challenges Ahead

82.   **The Fed has made a number of changes in preparation for rate increases, the timing of which they have stressed will be data dependent—the markets are pricing in the first rate rise in mid-2015.** The changes (below), including the testing of new instruments, are to ensure the Fed is operationally prepared to tighten conditions when the time comes:

- *The number of reverse repo counterparties has been increased* to 139 (18 banks, 6 Government Sponsored Enterprises, 94 money funds, and the 21 primary dealers).[50]

- *Testing of term reserves draining instruments:* Deposits[51] and reverse repos.

- *Testing of Overnight Fixed Rate Reverse Repos (ONRRP).* This instrument, first introduced in September 2013*,* could be considered either as similar to a *standing facility*—if accessible without restriction, or an *OMO*—if offered with an allotment cap. The instrument has been tested at fixed rates from 1 to 5 basis points and up to a recently increased cap of $10 billion per counterparty. Testing is partly aimed at identifying how the instrument impacts money market rates and intermediation flows, and its effectiveness in establishing a floor for overnight market rates.[52] The evidence to date suggests that the instrument *has* been effective in setting a floor under rates (Figure 4).

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[48] In December 2013 U.S. branches of foreign banks held $1 trillion of the reserves at the Fed representing 43 percent of total reserves but accounted for only 13 percent of banking assets in the U.S.A.
[49] Liberty Street Economics December 9, 2013: Who's Borrowing in the Fed Funds Market?
[50] These counterparties account for 25 percent of all overnight Treasury tri-party repo volume—(Potter speech).
[51] All banks are able to participate in term deposit auctions and not just those in the reverse repo counterparty list.
[52] FOMC Minutes: September 17–18, 2013.

83.   **In preparation for normalization, *decisions* and *clear communication* regarding two key parameters are vital: the *operating target* and its *positioning*.**

- **The fed funds rate should remain as the operational target during most (if not all) of the normalization period.** The prior is
to change the operating parameters
only where there is a clear benefit in
doing so. At this point, there seems no
clear benefit in moving away from the
fed funds target, while there could be
risks in doing so, given the
uncertainties about the behavior of
interest rates in different market
segments going forward. The use of
the fed funds rate in financial contracts
would also suggest that any change
should be communicated well in
advance, to allow market participants
sufficient time to adjust their
contractual arrangements.

Figure 4. Selected Interest Rates and the Fed's ONRRP

Source: Bloomberg and IMF estimates.
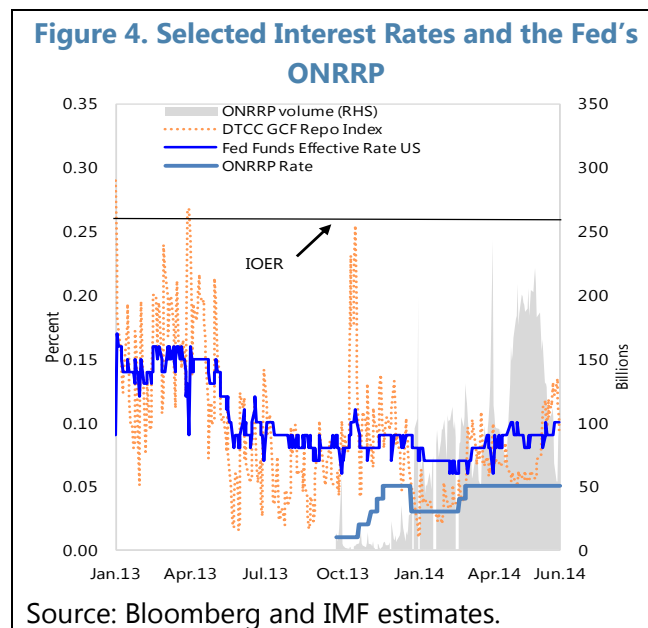
- **The Fed should target a single rate in the context of a floor system; with the target rate set equal to the IOER**. While a fed funds *target range* (0–0.25 percent) makes sense at interest rates close to zero, continuing with a *policy range* once the tightening phase has begun could undermine the clarity of the policy signal. If a policy range were to be retained, there is a question of whether the Fed would be indifferent to the fed funds rate trading anywhere within the announced range, or whether the mid-point of the range was in fact the implicit target. And if it were the latter, then why not return to a single-point target; and in the context of a floor system, *the fed funds target would equate with the rate set on the IOER*.[53]

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[53] The Fed should move away from the current approach of paying interest at the top of announced interest rate range. In all other cases, central banks pay interest on reserves to signal and set a floor under market rates.

- **The ONRRP, with an allotment cap to mitigate financial stability risks, would be the primary *monetary policy tool* to engineer an increase in the fed funds rate to, or slightly above, the IOER (Box 1).** With uncertainty about the ONRRP rate that is consistent with a fed funds rate trading at the IOER, the Fed could gradually increase the ONRRP rate until it achieved the fed funds objective. Periodically, given seasonal influences in the net-issuance of securities, the ONRRP rate may need to be changed to control the fed funds rate as desired, but any such change in the rate would *not* signify a change in policy – to be clear, the ONRRP is a *monetary policy tool* and *not a target*.

- **Using the new tools in an environment of abundant liquidity could result in more variation in the fed funds rate from the target than in the past, which should not be of concern given clear communication.** Moving back to a single rate policy target could be challenging but would not need to be achieved immediately upon announcement. A modest first step in the tightening cycle would be from the current target of 0–0.25 percent to 0.25 percent. That the fed funds rate does not immediately adjust to the target should not be a concern given an initial small change in the policy target, when combined with a credible commitment to achieve the target over the short-term (maybe one to three weeks). The Fed should also communicate clearly about the likely *challenges* of controlling the fed funds rate, suggesting that somewhat more volatility is possible, especially early on in the tightening cycle given the uncertainty about the demand for its new tools.

84. **Preparations for the effective control of money market conditions during normalization appear to be on track, but there are uncertainties ahead:**

- *The ONRRP may not always be sufficiently effective to move the fed funds rate to the IOER.* It is not certain that the counterparty list has been sufficiently expanded to control rates in a rising rate environment. Testing so far suggests that ONRRP rate has placed a floor under repo rates but volumes have been low with rates still compressed close to zero. It is not clear whether significantly larger volumes would be required once tightening begins, in order to have the desired impact on the fed funds rate; and if larger volumes were required, potentially more counterparties may also be needed. Further, limited access (12.45pm–1.15pm) may undermine the efficacy of the ONRRP once policy rates are increased, as up to half of tri-party repo (the bulk of the repo market) activity is reportedly conducted after 3pm (although as noted earlier the ONRRP has thus far set an effective floor).

Box 1. The Mechanics of Draining Reserves: the ONRRP and the Fed Funds Rate

The fed funds rate is determined by the interaction between the supply and demand for fed funds (Fed Funds Figure below) and the Fed's policy interest rates.[1] For any given demand curve, Fed operations that drain liquidity—whether overnight or for a term—move the supply curve left, resulting in an increase in the fed funds rate.[2] Currently the fed funds rate trades below the IOER because of: 1) abundant liquidity (S1), and 2) constraints on some banks' ability to arbitrage between the providers of fed funds that are not able to receive the IOER and the IOER. These constraints are largely regulatory in nature—capital, leverage, liquidity, and the FDIC levy—but may also reflect an unwillingness of the GSEs to make placements with certain banks.

If the Fed wanted to increase the fed funds rate to a level *at or slightly above the IOER*, then it would have to reduce the supply of fed funds by magnitude "A." This objective could be achieved in principle by offering the fixed volume 'A' of term sterilization instruments, but in doing so the Fed would have to accept the market clearing rate on the instruments. This approach is problematic from two perspectives: 1) significant uncertainty about the demand curve for fed funds makes it difficult to assess "A," and 2) term instruments would incur a term premium.

The ONRRP is a fixed rate instrument offered by the Fed. The Fed's demand for funds (i.e., the scale of ONRRP operations) is perfectly inelastic while the market's supply curve of funds is upward sloping (ONRRP Figure below). There are two impacts here: 1) The ONRRP rate sets *a floor under repo rates*; participants would not deal at a rate lower than what the Fed was offering. The solidity of this floor is however contingent on the breadth of the counterpart list – which has been addressed through the increase in the number and type of counterparties. 2) Funds placed in the ONRRP are funds that are withdrawn from banks, therefore the supply of fed funds falls (the fed funds supply curve moves left), putting *upward pressure on the fed funds rate*.

The Fed is acquiring information about the market's supply curve for the ONRRP by varying the rate but the information to date is limited given the highest rate offered is 5 basis points, and the volumes have been capped. Consequently, there is considerable uncertainty about market behavior when ONRRP rates approach the IOER. However, when the time comes for an interest rate rise, the Fed can move slowly, increasing the ONRRP rate in small steps until the desired fed funds rate is achieved. This process would further reveal the supply curve for ONRRP and the demand curve for Fed funds, recognizing that these curves move over time. Market commentators have variously suggested that the ONRRP rate could be set at 0 to 15 basis points below the IOER. A driver of this spread is the FDIC levy which is around 12 basis points; a spread lower than this level provides the money market mutual funds with an advantage (since they don't pay the levy) allowing them attract more funds from banks thereby putting upward pressure on the Fed funds rate. And a higher spread could well result in the fed funds rate remaining below the IOER. But only when the time comes, will it be clear where ONRRP rate will need to be, to exert the desired pressure on the fed funds rate.

Box 1. The Mechanics of Draining Reserves: the ONRRP and the Fed Funds Rate (Continued)

The ONRRP offers Fed counterparties with a *safe asset* given the use of Treasuries and Government guaranteed mortgage backed securities, and with the Fed as counterparty. The supply of this safe asset is limited only if the Fed limits access to the ONRRP, for example with the allotment cap (currently set at $10 billion per counterparty). Financial stress would increase the demand for safe assets—moving the ONRRP supply curve to the right (S2), and the fed funds supply curve to the left. The more acute the financial stress the further the curves move, with potential to push banks to the Fed's Primary Credit Facility (S3)—the demand curve for fed funds would also move up exacerbating the impact on the fed funds rate. Counterparty caps limit the extent to which the ONRRP supply curve could move to the right, and as such are useful to contain disintermediation pressures in the banking sector. And lowering the rate on the ONRRP also could reduce flows into the instrument. However, it is unclear that fine-tuning the counterparty cap and/or the ONRRP rate would provide a sufficiently effective response in a severe stress scenario; a more targeted approach may be required depending on the circumstance.
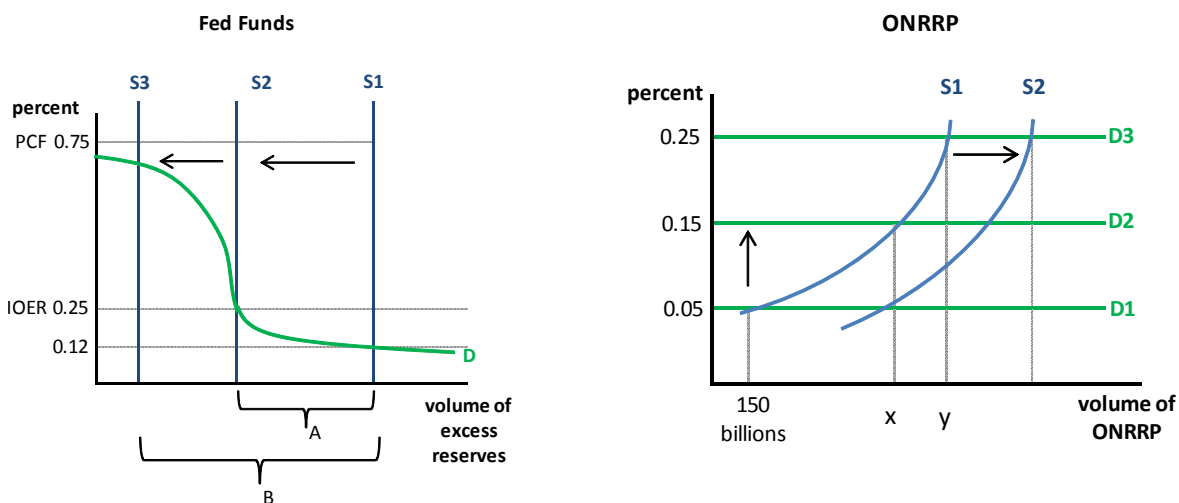
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[1] The demand curve is a stylized illustration of what is may look like.
[2] To the extent the demand curve is sloping; at current levels of oversupply it is virtually flat.

- ***Financial stability risks arising from disintermediation of the banking sector.[54]*** These risks could arise if deposits are attracted out of banks and into money market mutual funds—increasing the size of the less-tightly regulated shadow banking system.[55] Further, in times of financial stress there could be runs *into* money funds— exacerbated by some funds having publicized their access to an unlimited volume of safe assets (i.e. the ONRRP). Risks of disintermediation increase if the instrument is offered without an allotment cap.

- ***Operational challenges of conducting large volumes of overnight transactions.*** Each day, transfers of *securities* and *cash* will be required. While only small volumes of transactions are currently conducted, much larger volumes may be required to move the fed funds rate closer to the IOER (maybe in excess of $1 trillion), which could potentially double the current tri-party repo volumes. Such a surge in volumes would increase the operational and financial risks related to settlement.[56]

Steps to Improve Implementation and to Mitigate Risks

85. **Measures could be considered to increase the solidity of the interest rate floor:**

- *Further expanding the number of counterparties,* if rates traded below the ONRRP rate. There could be important segments of liquidity unable to access the instrument (e.g., a large number of investment intermediaries which fall below the threshold to become counterparties); this could be addressed by further expanding the counterparty list. The resulting increased risks of disintermediation (i.e., funds flowing out of banks into money market funds) would need to be mitigated by:

  ➢ *Maintaining and managing the allotment cap on the ONRRP.* The allotment cap impacts only on the non-banks, as banks will not use the ONRRP because of access to IOER (which pays a higher interest rate). The caps should be maintained to mitigate financial stability risks (see Box 1) and be set at a level that allows the Fed to meet its operating objectives. A uniform cap across counterparties is the easiest to administer, while recognizing proportionally larger counterparties may be disadvantaged with this approach.

  ➢ *Managing the ONRRP rate, relative to the IOER.* A significant move of funds out of banks would push the fed funds rate up which could be countered by a lowering of the ONRRP

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[54] William Dudley, President FRBNY Speech May 20, 2014: The Economic Outlook and Implications for Monetary Policy.
[55] Regulatory arbitrage is likely given that banks are subject to capital, liquidity and FDIC costs and other counterparties are not.
[56] Because haircuts are not applied to reverse repo transactions, the Fed is exposed to market risk if a counterpart defaults and if the value of the security has increased – albeit a small risk in the context of overnight transactions. Further large volumes of overnight deals increase the intra-day exposures in the tri-party system, something that has been the focus of the Tri-party Repo Infrastructure Reform Task Force to reduce.

rate. *The ONRRP will probably be set below the IOER to compensate for the FDIC levy and other regulatory costs that fall on banks but not on money market funds.*

- *Extending the timing of the operation.* When the ONRRP is not available there would be no effective lower bound on rates. Therefore, it may be necessary to extend the ONRRP operation to much later in the day when a significant volume of overnight deals are done.

	Counterparty Relevance	Format	Costs	Reserves Draining Impact	Post-Normalization
Reserve requirement	Banks	Administrative	IOER [1]	Permanent (until changed)	Not recommended
IOER (policy rate)	Banks	Standing facility [2]	IOER	None	Yes
Term deposits	Banks	Auction (fixed price or fixed quantity)	IOER *plus* term premium	Temporary	Not required
ONRRP	Non-banks	Standing facility (maybe capped)	IOER *minus* margin	Temporary	Not recommended
Term RRP	All	Auction (fixed price or fixed quantity)	ONRRP *plus* term premium	Temporary	Yes (small volume)
Asset sales	All	Auction / Bi-lateral transactions	At market prices	Permanent	Not required [3]

Table 1. Summary of Instruments' Costs and Impacts

[1] This assumes the current policy of remunerating required reserves at the same rate as excess reserves, although the Fed could choose to apply different rates to each category of reserves.
[2] A standing facility is an arrangement offered by the central bank that can be utilized at the discretion of depository institutions and generally without restriction. Payment of interest on excess reserves (IOER) has these characteristics.
[3] The FOMC has suggested there could be residual MBS sales after normalization.

86. **Term sterilization instruments would reduce the heavy reliance on overnight operations but would carry additional cost.**[57, 58] A mix of term deposits and term reverse repos could be used to tighten liquidity conditions, thereby reducing segmentation and operational risks. Term deposits, would incur a term premium above the IOER, while term reverse repos would incur a term premium above the ONRRP (but could still be below the IOER). The liquidity premium on term reverse repos is to some extent, a function of the liquidity constraints on money market mutual funds, something that could be mitigated by attaching a 7-day put option to the instrument; something the Fed has also tested.

H. Considerations for the Future Shape of the Operating Framework

87. **The current juncture provides an opportunity for a broader review of the operating framework.** The post-exit framework will be different to that of today, and probably that of the pre-crisis period. Abundant liquidity currently limits operational choices, yet it should still be possible to implement changes along the path to normalization; i.e. that being the point where the Fed's balance sheet reverts to a *steady state*.

88. **Differences in interest rate targeting frameworks come down to a few key areas:** (1) Specification of the operating target; (2) positioning of the operating target; (3) instrument design; (4) counterparty selection; and (5) collateral policy. Each of these issues except collateral policy is discussed in subsequent sections and Table 2 provides a country comparison.[59]

Specification of the Operating Target

An implicit or explicit operating target?

89. **Central banks can influence financial conditions by targeting interest rates, either implicitly or explicitly.**[60]

- **With an implicit target there is no market rate announced as a target.** The *policy target* is tied to a central bank instrument in the expectation that short-term *money market rates* will remain close to the level at which there is commitment to add or withdraw liquidity.[61] Idiosyncratic movements in individual market rates therefore matter less. However, market

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[57] Some central banks use foreign exchange swaps as a liquidity management instrument but this is not feasible for the Fed as it has few foreign reserves to swap into dollars and borrowing the reserves could be costly.

[58] Higher reserve requirements could complement the toolkit during normalization. However statutory limitations on the types of reservable accounts and the maximum level restrict the potential impact.

[59] With Fed's balance sheet returning a small deficit and with abundant supply of US government securities, there no requirement to expand the collateral pool used for normal monetary operations. Further, the collateral policy for the Discount Window (LOLR) is well defined and sufficiently broad to meet current needs.

[60] Conventional monetary policy works through *actual and expected real short-term risk free rates* while unconventional policy aimed to impact expectations of short-term rates (through forward guidance) and the term premium through the asset rebalancing channel (LSAPs).

[61] This excludes transactions at central bank standing facilities which are priced at penalty rates.

rates may move away from the policy rate when the interbank market is fragmented and some banks have a higher demand for liquidity than others (e.g., Euro area).

- **An explicit target involves a commitment to guide an identified market rate (or rates) consistent with an announced policy target.** This option may require a more active approach, as operational credibility relies on central bank actions to contain deviations of the targeted rate from the announced target.

Table 2. Operational Features of Interest Rate Targeting Regimes

	USA	ECB	BOE	Sweden	Australia	Canada	Brazil	Chile
Operating Target								
Explicit or Implicit	Explicit	Implicit	Implicit	Implicit	Explicit	Explicit	Explicit	Explicit
Which (explicit) rate	Unsecured	NA	NA	NA	Unsecured	Composite	Repo	Unsecured
Floor or Mid-corridor								
Pre-crisis	No Floor defined	Mid	Mid	Mid	Mid	Mid	Mid	Mid
Current	Above the floor	Mid	Floor	Mid	Mid	Mid	Mid	Mid
Corridor Width	75 bps	25 bps	75 bps	150 bps	50 bps	50 bps	160 bps	50 bps
Main instrument (pre-crisis)	Overnight repos	1-week repos	1-week repos	1-week repos [1]	OMOs [2]	Overnight repos	OMOs	OMOs
Reserve requirements	Yes	Yes	Suspended in 2009	No	No	No	Yes	Yes

[1] More recently liquidity has been withdrawn at the weekly operation owing to a structural surplus.
[2] Open Market Operations (OMOs) comprise a range of transactions conducted by the central bank including repos, reverse repos and outright purchases and sales of securities.

90. **The Fed should continue to announce an explicit operating targeting.** Central banks have successfully employed both implicit and explicit approaches to the operating target (Table 2). As neither approach has been proven demonstrably superior, the Fed should retain an *explicit target* recognizing there is no clear advantage in changing.

Options for an explicit operating target

91. **Post-normalization, the choice of *operating target* will be guided by an assessment of the relevance of interest rates in different segments of the money market.** And, with more regulatory changes to be phased in over the years ahead, there is uncertainty about how the different segments will function. Three main options for targeting short-term interest rates are available—the fed funds rate (an unsecured overnight rate), a repo rate (a secured overnight rate) and a composite (reflecting money market conditions with indicators of which rates are most important).

Maintaining the fed funds rate

92. **The fed funds market has shrunk and it is uncertain by how much it will recover.** Risk aversion during the crisis reduced activity in the unsecured markets globally, in absolute terms and relative to activity in secured markets. In the U.S. a number of regulatory changes—capital, leverage, liquidity, and the FDIC levy—require banks to have more stable funding, relative to short-term financing. And there is evidence of diminished transmission of the fed funds rate to longer rates, but this should be treated with caution given the prolonged period of compressed rates.[62] Undermining the case for retaining the fed funds target is the likelihood that activity in the unsecured market is likely to remain subdued. It could be retained if activity did recover, and providing there was a sufficiently close relationship with movements in other money market rates.

The General Collateral Repo Rate (GCRR)

93. **The treasury GCRR is an alternative to the fed funds rate.**[63] The value of tri-party repo transactions is around $1.7 trillion with about one third relating to the treasury general collateral category, although the breakdown between overnight and term transactions is not available.[64] However, using the FICC-GCF repo data[65] as a proxy, around one third of the transactions may be overnight—equating to $190 billion (compared to fed funds estimated at $60 billion). With money

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[62] Klee and Stebunovs December 2012: Target Practice: Monetary policy implementation in a post-crisis environment—page 22.

[63] The GCRR is based on a daily survey conducted by the FRBNY which is not publicly available. The DTCC General Collateral Finance (GCF) repo rate for treasury securities is suggested as a good proxy for the GCRR: Klee and Stebunovs 2012.

[64] FRBNY Tri-party repo data April 9, 2014. Data is obtained on the 7th business day each month, selected as being typical business day.

[65] Fixed Income Clearing Corporation (FICC)—General Collateral Finance (GCF) repos are transactions between dealers.

market mutual funds active in tri-party repos and other segments—short-term US treasury and corporate securities and the bi-lateral repo market—arbitrage ensures that changes in the GCRR are widely transmitted. Also relevant is the transmission from the GCRR to the repo yield curve, which appeared to remain more stable when compared to the unsecured lending curve.[66]

94.   **The Fed could exert control over the GCRR—albeit with added complexity given the role of collateral.** Pre-crisis, the GCRR responded predictably to movements in the fed funds rate, but this relationship weakened at the onset of the crisis as risk premiums and liquidity increased.[67] Repo rates are affected not just by changes in liquidity, but also by seasonal influences affecting the net-issuance of treasury securities.[68] While abundant liquidity has weakened the short-term liquidity effects, when excess reserves run down, the liquidity effects should strengthen, with arbitrage activity recovering. With a balance sheet back at *steady state*, the Fed should then be able to manage the GCRR in a similar way to the fed funds rate pre-crisis, albeit with added complexity given the role of collateral and the uncertainty about the extent to which arbitrage activity recovers.

A composite approach could be considered

95.   **Individual rates—including the GCRR—have been hit by idiosyncratic shocks complicating policy implementation.**[69] Going forward, the GCRR is certainly a viable option for a *single rate* operating target, yet it was impacted during the financial crisis (2008) when risk aversion resulted in a sharp fall in the rate, and again during the debt ceiling negotiations (2013) when, as the default risk on short-term treasuries spiked, so too did the rate. Rigid implementation responses in these circumstances, when a single rate is targeted, could exacerbate volatility in other markets undermining policy signals and effectiveness.

96.   **To get around this problem the Fed could target *the general level of short-term rates, while providing clear guidance on which rate was the most important indicator.*** When a single-targeted rate moves but other short-term rates do not (or move by much less), from a policy perspective, there is no need for an immediate response to bring the rate back to the target; yet failure to act could pose communication challenges and risk credibility. To get around this problem, a combination of money market rates could be considered. The GCRR could be of primary importance—and communicated as such—but the fed funds rate and EURO dollar rates could also be used with lesser emphasis, as well as term rates (repo and bank certificate of deposits).

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[66] Klee and Stebunovs December 2012: Target Practice: Monetary policy implementation in a post-crisis environment—page 22.
[67] Bech, Klee and Stebunovs 2011: Arbitrage, liquidity and exit: The repo and federal funds markets before, during and emerging from the crisis—Tables 4, 5 and 6.
[68] Klee and Stebunovs 2012: Target Practice: Monetary policy implementation in a post-crisis environment – page 20.
[69] Incorporating Financial Stability Considerations into a Monetary Policy Framework Jeremy Stein, March 21, 2014: Highlights the frequency of events that impact term and credit risk premiums.

97. **A less rigidly specified target rate would need to be clearly communicated.** In choosing between a single rate target and one more loosely defined, the trade-off is clear: *signaling clarity* vs *flexibility*. The signaling challenges can be met by communicating which rates are important, and why. And it should be noted that a moderate amount of volatility in all rates is expected and would not undermine the operational objective.

Positioning of the Operating Target

98. **Interest rates are targeted either at the floor or the mid-point of the corridor.** Prior to the financial crisis many central banks targeted the mid-point of the corridor, but liquidity injections aimed at addressing financial stability concerns subsequently pushed rates to the bottom of the corridor (a *floor system*) in a number of cases (e.g., BOE, ECB, and U.S.). In the U.S., bank reserves are currently remunerated at the top of the announced policy range (0.25 percent) with discount window borrowings available at a 50 basis points higher rate (0.75 percent). During normalization there is little choice for the Fed other than to adopt a type of floor system—determined by the interest rates applied to IOER and the ONRRP. As structural liquidity declines however, there will be the option to revert to a mid-corridor system.

99. **There is a good case to retain the floor system beyond normalization because it is operationally less complicated and more robust through the risk cycle (Appendix I).** The potential loss of bank information from subdued trading—an often-cited benefit of retaining a mid-corridor system—is countered through the stringent reporting requirements of the new liquidity regulation. And retaining the floor system post-normalization reduces the need for change once the Fed's balance sheet has reverted to a steady state.

Instrument Design

100. **The supply of reserves should be *just* sufficient to keep rates at or slightly above the floor, to ensure institutions have some *liquidity risk* to manage.** To illustrate (Figure 5), with a mid-corridor system and an assumed policy rate of 50 basis points and amount of reserves at S2 would be required to meet the policy target. In the case of a floor system and with a policy rate of 25 basis points, then S1 volume of reserves is required. Strictly defined, implementation of a floor system would require the level of reserves to be at some point to the right of S1; thereby always pushing rates always to the floor. However, more liquidity means less liquidity risk, and less market activity. Therefore, a less rigidly applied approach to the floor system with liquidity provided at S1, would retain some liquidity tension, increasing trading, but with a consequence that the rate may on occasion trade above the floor.

Figure 5. Floor versus Mid-Corridor Systems

Floor versus mid-corridor systems
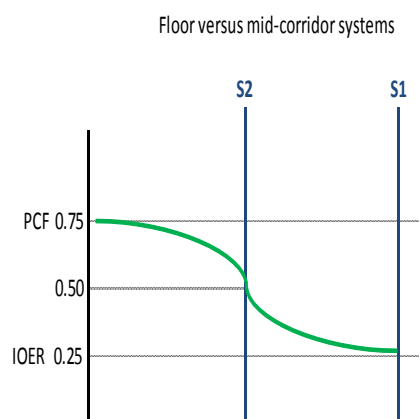
101.   *Standing facilities* **at the floor and the ceiling of the corridor are needed:**

- **The IOER will again become effective as the large structural surplus shrinks, allowing for a withdrawal of the ONRRP in its current form.** Active arbitrage will reduce market segmentation, thereby establishing the IOER as an *effective floor* under rates. While high liquidity and segmentation necessitated the introduction of ONRRP—*to fix the floor*—a return to tighter conditions means this instrument is no longer needed, and given the disintermediation risks it should be removed as soon as possible.

- **The Primary Credit Facility (PCF) establishes a ceiling rate, but this may involve stigma.** The PCF is for highly rated banks and intended to provide a safety valve for liquidity pressures. [70] It still may not be fully effective because of stigma as the Fed must, with a two year lag, disclose its lending activity.

102.   **Instruments to manage short term liquidity fluctuations are still needed.** Fine-tuning operations will need to offset seasonal influences given the GCRR may respond to changes in both reserves, and the net-issuance of collateral. The Fed would need to use its portfolio of treasury securities through repo operations best offered as a variable rate/fixed volume format. This approach differs to its operations pre-crisis in that while the operations were variable rate, it did not announce an amount, thereby providing greater flexibility to determine an outcome consistent with its interest rate objective. If the Fed wishes to continue with this approach, information should—as before—be provided post-auction on the results of operation, to help market participants better assess liquidity conditions in support of more stable market conditions. Noted is that the Fed's auction facilities during the crisis involved detailed pre- and post-auction information on volumes and rates.[71]

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[70] A Secondary Credit Facility is available to lesser rated institutions with restrictions on the use of fund—it is therefore more akin to a lender of last resort arrangement. It is currently priced 50 basis points above the PCF.
[71] Armantier and Sporn: Federal Reserve Bank of New York Staff Report 635 September 2013: Auctions implemented by the Federal Reserve Bank of New York during the Great Recession

103.   **The reserve requirement no longer meets any monetary policy or liquidity management objective and can be withdrawn (Appendix II).** Eliminating the reserve requirement would free up reserves, thereby increasing excess reserves and reducing the need to inject additional liquidity.[72] There would also be administrative savings.

Counterparty selection

104.   **Counterparty selection can be differentiated on the basis of instrument type:**

- *Standing facilities:* The IOER and the discount window facilities are limited to depository institutions, and this should not change.

- *Open market operations:* Regulatory developments (LCR and the supplementary leverage ratio) are likely to have undermined the Fed's ability to implement policy through the traditionally narrow set of primary dealers. However, beyond normalization, and in the context of an increased focus on the GCRR, the Fed may need to transact in larger volumes. With these considerations the expanded counterpart list is appropriate and should be retained, with an additional benefit of enhanced competition in the Fed's OMOs. A caveat being, only banks should have access to standing facility-type instruments (i.e. fixed rate instruments with or without limits) to mitigate disintermediation and subsequent financial stability risks.

I.   Summary

105.   **The recommendations for the *normalization period* are summarized:**

- Continue with the fed funds rate as the operating target of monetary policy.

- Announce that a floor system will be used during most, if not all, of the normalization period, and therefore the rate set on the IOER will equate with the fed funds target.

- Use the ONRRP, with counterparty allotment caps, as the primary monetary policy tool to manage the fed funds rate at or slightly above the IOER.

- Assess the need for further expanding the counterpart list if the ONRRP is not sufficiently effective.

- Manage the dis-intermediation and shadow banking risks of the ONRRP by announcing that it is unlikely that the instrument will be used post-normalization and that allotment caps may be changed to contain flows.

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[72] The amount of reserve balances used to meet reserve requirements in March 2014 was $78 billion.

- Re-instate the single rate policy target; with the first modest move from the current 0–0.25 percent to 0.25 percent. Communicate the prospect that given abundant liquidity, there could be somewhat higher variation around the policy target than in the past.

- Explore the use of term sterilization instruments—deposits and reverse repos—to lessen operational risks. Small term premiums could be justified to reduce the burden of a daily rollover of large transaction volumes.

106.   ***Post-normalization* considerations:**

- Consider alternate operating targets after it is clear how markets have adapted to the regulatory changes. Consider de-emphasizing the importance of a single rate in favor of focus on the *general level of money market rates*, while highlighting what the Fed considers to be the most important indicators (e.g., GCRR, Fed funds rate).

- Continue with the floor system.

- Withdraw the ONRRP: because the IOER will provide an effective floor once liquidity conditions tighten.

- Use short-term repos and reverse repos to manage the operating target close to floor.

- Abolish the reserve requirement, as it provides no benefit and is administratively cumbersome.

Appendix 1. Floor versus Mid-Corridor Systems

This appendix outlines the considerations when deciding between implementing a floor system, where the policy target rate is set at the *floor of the corridor*, and a mid-corridor system where the policy target rate is set *away from the floor* (but not necessarily at the mid-point).

Floor System

Advantages

There may be less variability between market and target rates. The combination of abundant liquidity and an *effective floor* anchors rates at the floor, thereby aligning market rates more precisely with the targeted rate.[1]

Higher reserve balances (than required in a mid-corridor system) may facilitate an increased supply of high quality liquid assets (HQLA).[2] Higher reserves levels could help alleviate a shortage of HQLA—although not a current concern in the U.S.—and support the function of the payments system.

The price/quantity nexus is removed, thereby providing more flexibility in times of stress. The IOER was introduced in 2008 at time when the Fed sought to put a floor under rates, while simultaneously increasing liquidity to counter mounting financial stresses. In these situations rates trade at the floor, facilitating a break in the price/quantity nexus—quantity can be increased—to a point—without impact on price (subject to the solidity of the interest rate floor and market segmentation issues which will impact at some point). A floor arrangement is therefore likely to be more robust across different phases of the risk cycle.

Less operational resource and fewer monetary instruments are required. Larger reserve balances would mean less need for accurate forecasting of the influences on reserves, and most likely, less fine-tuning operations to offset those influences.

There would be a positive impact on central bank profitability given the somewhat larger balance sheet. The higher level of reserves, incurring interest costs at the policy rate, would be matched against term assets earning the term premium.

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[1] An important operational decision is the extent to which liquidity is *oversupplied*, as greater oversupply reduces the prospect of rates moving away from the floor.
[2] The impact on HQLA will depend upon how the reserves are supplied to the system. If they are supplied through the purchases of HQLA, then there will be no net change in the volume of HQLA. However, HQLA will increase when non-HQLA transactions are undertaken (e.g., repos with non-HQLA or foreign exchange swaps).

Disadvantage

Abundant liquidity reduces both liquidity risks and the incentive to trade in interbank markets, with a potential loss of information. The question arises whether less activity reduces the incentives and scope for peer-monitoring, leading to a loss of information about individual banks solvency, with negative financial stability consequences. While some literature supports this view,[3] others highlight that because interbank trading is very short-term, there is little focus on the long-term solvency of the borrowing bank.[4] Active interbank markets did not prevent the recent financial crisis (much of which was bank-sourced), so the benefit of active interbank markets should not be overstated.

Mid-corridor System

Two-way liquidity risk encourages trading and perhaps better transmission along the yield curve. With a greater incentive to manage liquidity, transmission along the short part of the yield curve would be stronger, given that rates are not forced to the floor.

Liquidity management is more challenging but could be mitigated by the use of a reserve requirement (or some form of contractual reserves) with averaging. With no liquidity buffer, frequent fine-tuning operations would be required to manage supply against forecasted demand in order to meet the targeted rate. Reserve requirements with full averaging would reduce interest rate volatility that would arise when supply and demand were not aligned on a particular day. A contractual reserves approach requires banks to reveal their demand for precautionary reserves, and combines incentives for them to manage their position in a manner consistent with their stated reserves position.[5]

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[3] Rochet and Tirole 1996: Interbank Lending and Systemic Risk.
[4] Bernhardsen and Kloster, Norges Bank, 2010: Liquidity Management System: Floor or Corridor?
[5] The BOE pre-crisis, allowed banks to nominate their reserves levels at the start of each maintenance period.

Appendix 2. A Short History of and the Case Against Reserve Requirements

History

The use of reserve requirements in the USA can be traced back to voluntary redemption arrangements in the 1820s. Bank notes were used as a medium of exchange, but limited information on the solvency of the issuer meant the geographical coverage for an individual bank's notes was narrow. Banks in New York and New England agreed to redeem each others' notes at par, providing the issuing bank maintained sufficient specie (gold or its equivalent) at the redeeming bank. This first use of required reserves was, in essence, for prudential reasons.

On a nationwide basis reserve requirements were first established under the National Bank Act (1863). The charter established a network that banks could join, requiring them to hold a 25 percent reserve against bank notes and deposits. This network facilitated greater countrywide acceptance of notes of the participating banks. From that point until the establishment of the Fed, reserve requirements continued to be viewed as a prudential measure to support the liquidity of bank notes and deposits (under the prevailing gold standard, by linking them to physical gold reserves), yet financial panics still occurred.[1] By 1931, after the establishment of the Fed, and with it a lender of last resort function, reserve requirements were used to influence the expansion of bank credit and were no longer viewed as a prudential tool. Membership of the Fed was optional for state-chartered banks and some began leaving the system to take advantage of lower reserve requirements imposed by state authorities. By the late 1970s, less than 65 percent of total transaction deposits were held at Fed member banks. Congress introduced the Monetary Control Act (1980) mandating the Fed to set reserve requirements universally across all depository institutions.

From the early 1980s, the Fed aimed to influence monetary and credit conditions by adjusting the cost of reserves to depository institutions. Actual reserve balances were stabilized around the minimum level needed to meet requirements and clearing purposes (as reserves were not remunerated, banks kept balances as low as possible). Individual banks could however, contract to hold more reserves if they deemed their clearing needs were higher than the requirement, and this excess earned credits that could be offset against Fed priced services. The reserve requirement was averaged over the two-week maintenance period for larger banks and one week for smaller banks.

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[1] The U.S.A. experienced a number of financial panics during 1869, 1873, 1893, and 1901.

The Fed was first able to remunerate reserve balances in October 2008.[2] The rate paid on *required reserves* was originally set at the average of the Fed funds target over the maintenance period less 10 basis points, while *excess reserves* were remunerated at the lowest Fed Funds target rate during the period, less 75 basis points. These margins were removed from early 2009: both categories of reserves are now remunerated at 25bp, the top end of the fed funds target rate.

The Case for Abolishing Reserve Requirements in the U.S.A.

The current arrangements are complex and administratively burdensome.[3] Depository institutions report either on a weekly or quarterly basis, depending on the size of their net transactions accounts and other accounts.[4] Reserves are maintained over a two-week period, which in the case of institutions reporting weekly, is based on two reporting periods and lagged to the computational period by 17 days. The computation period for institutions that report quarterly is the 7-day period beginning on the third Tuesday of the report month, with compliance lagged by four, or in some cases five weeks. The reservable base covers *net transactions accounts* split in three tranches—up to $13.3 million is reservable at 0 percent (referred to as the low reserve tranche), $13.3.million to $89 million is reservable at 3 percent, and more than $89 million is reservable at 10 percent.[5] The low reserve tranche is adjusted each year by 80 percent of the annual increase or decrease in net transaction accounts at all depository institutions. The impact of reserve requirements was reduced in 1990 when the ratio on non-personal time deposits and Eurocurrency liabilities was set to zero.

Institutions can satisfy their reserve requirements through holdings of vault cash and reserve balances.[6] Vault cash covers in excess of 40 percent of the requirement for the system as a whole, and more than 100 percent of the requirement for some banks. A penalty-free band is calculated as the greater of $50,000 or 10 percent of the reserve requirement. When an institution has more than the sum of its reserve requirement plus the penalty free band, it is deemed to be in excess.[7] If it has less than the reserve requirement minus the penalty-free band, then it is in deficit and will be subject to penalty set at the rate on the Primary Credit Facility plus one percentage point.

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[2] The Financial Services Regulatory Relief Act (2006) originally authorized the Fed to pay interest on reserves beginning October 2011. This authority was superseded, as a result of the financial crisis, by the Emergency Economic Stabilization Act (2008), bringing forward the authority to October 2008.

[3] Board of Governors of the Federal Reserve System: Reserve Maintenance Manual—November 2013.

[4] There are two further categories of reporting—annual and non-reporters. Institutions in these categories have net transactions accounts of less than the amount specified as the low reserve tranche.

[5] Net transactions accounts are total transaction accounts, less amounts due from other depository institutions, and less cash items in the process of collection. Total transactions accounts include demand deposits automatic transfer service accounts, NOW accounts, telephone and pre-authorized transfer accounts, and others.

[6] There are also pass-through arrangements that allow institutions to meet their requirements through a correspondent bank.

[7] The distinction between required reserves and excess reserves is less relevant now that both categories of reserves are remunerated at the same rate.

Reserve requirements in the U.S.A. no longer play a prudential or monetary role *and* may not be needed for liquidity management. Many central banks now operate an effective operational framework without reserve requirements.[8] Other central banks that use them aim to stabilize the demand for reserves, thereby improving liquidity management outcomes. The key features of these arrangements are requirements that result in reserve levels close to that which is voluntarily demanded for a given remuneration rate (typically at the policy rate or up to 25bp below it), a relatively long maintenance period (around a month), and full averaging.

Monetary policy could be implemented effectively in the USA using a floor system and without reserve requirements.[9] Liquidity management in a floor system involves keeping interest rates at, or close to the floor. Consequently there is a one-way risk of not meeting the operational target—assuming that there is an effective interest rate floor, the market rate can only be too high. With rates pushed to floor of the corridor, there is less of a requirement to fine-tune operations, and as a result, less need to accurately forecast and stabilize the demand for reserves. However, there is still a need for periodic operations, perhaps in both directions (injecting and withdrawing liquidity) as the objective should be to *over-supply* liquidity only by a small margin, to ensure that money market activity is not undermined by a high volume of excess liquidity (as it is currently). A flexible form of required reserves (contractual reserves) where banks reveal their demand for reserves could however be useful in a mid-corridor system to reduce uncertainty.[10]

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[8] From the IMF - ISIMP 2013 survey, 10 central banks implement monetary policy without using reserve requirements, these include Australia, Canada, Denmark, Mexico, New Zealand, Norway and Sweden.

[9] Current examples of counties using the floor system are Norway, and New Zealand.

[10] In 2006 the Bank of England (BOE) operated a mid-corridor system and introduced a *contractual reserves,* system which forced banks to reveal their demand by nominating the amount of reserves they intended to hold during a given maintenance period. The maximum amount a bank could nominate was limited to the lower of; two percent of their sterling liabilities, or £3 billion. Banks were remunerated at the policy rate when they held average balances through the maintenance periods of within +/- 1 percent of their nominated amount. No remuneration was paid if the balances were above this range, and a penalty was charged for balances below this range. This system was suspended during the financial crisis, as the BOE embarked on a policy of quantitative easing which pushed rates to the floor of the corridor.

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FISCAL RISKS AND BORROWING COSTS IN STATE AND LOCAL GOVERNMENTS[88]

State and local governments (SLGs) face important fiscal challenges, most notably because of the unfunded liabilities they have under public employee pension plans and related to other post-employment benefits. This chapter examines the state of SLG finances with a focus on how challenges posed by such liabilities and political polarization that may hinder implementation of policies to address them are priced in by municipal bond markets. Analysis suggests that state borrowing costs will increase if unfunded liabilities are left unchecked and that certain budget institutions may help contain the negative impact of unfunded liabilities and political polarization on borrowing costs. This highlights the need for public pension and budget process reform.

A. Introduction

107.   **In the wake of the Great Recession, fiscal imbalances in the U.S. have surfaced at all levels of government**. The federal budget deficit as a percentage of GDP widened rapidly from 1¼ percent in 2007 to 11½ percent in 2009 and remained above 3 percent in 2013, while debt held by the public rose from 35 percent of GDP in 2007 to 74 percent in 2013. The aggregate SLG deficit as a percentage of GDP, measured on an annual basis, reached 2½ percent in 2009—the widest since 1980s—with gross debt increasing considerably from 25 percent of GDP in 2007 to 29 percent in 2013.[89]

108.   **These imbalances raise concerns about the sustainability of public finances and, for SLGs, put upward pressure on financing costs**. Indeed, municipal bond spreads over Treasuries rose sharply during the crisis and remain well above historical averages (Chart).[90] Moreover, several states suffered from credit downgrades in 2009–11, including those with large stocks of debt such as California, Illinois, and New Jersey. Admittedly, the reserve currency status of the dollar and safe haven flows into the Treasury market have, so far, helped keep federal borrowing costs at historical lows despite the sharp rise in federal debt held by the public. However, the lack of a consolidation plan to stabilize medium-term debt dynamics and doubts about the effectiveness and predictability of policymaking amidst political polarization led to a sovereign credit rating downgrade in August

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[88] This chapter was prepared by Madelyn Estrada, Deniz Igan, and Dinah Knight. It has greatly benefited from discussions with Rabah Arezki, Ravi Balakrishnan, Kathleen Byrne, Roberto Cardarelli, Nigel Chalk, Matt Fabian, Tracy Gordon, David Jones, Lusine Lusinyan, Marcelo Pinheiro, and Tigran Poghosyan.

[89] All years refer to calendar years. Federal government deficit figures include IMF staff's adjustment for financial sector support costs. It should be noted that all states save Vermont have a balanced budget rule in place on a fiscal year basis (over two fiscal years in some states), but how binding the rule is varies across states. Technically, SLGs may not issue debt to close budget gaps (although they sometimes find ways around this constraint or legislate one-time fixes), hence the smaller increase in the SLG debt level compared to the federal debt held by the public.

[90] In fact, municipal bonds tend to have lower yields than Treasuries because of their tax advantage, offsetting their illiquidity. Since the crisis, the "muni/Treasury ratio" has consistently exceeded 100 percent.

2011.[91] Consequently, a spike in Treasury yields as a result of sustainability concerns building up poses an important risk, with implications for SLGs.

109.   **Post-employment obligations and the associated uncertainty keep concerns about SLG finances alive even as short-term fiscal balances improve, including the crowding out of much needed education and infrastructure spending**. The losses suffered by public pension funds during the crisis and high-profile municipal bankruptcies brought awareness about the long-term challenges. Increasing underfunding in government-sponsored pension plans means additional unsecured debt.[92] Moreover, legal uncertainties exist when it comes to the seniority status of existing, general obligation debt to such additional debt. As a result, borrowing costs for SLGs may come under pressure. Furthermore, the higher debt service costs materializing as a result of unchecked post-employment obligations compete for resources that could otherwise be devoted to education and infrastructure spending. Already plagued with narrow, eroding tax bases and volatile revenues, SLGs also face a reduction in the sources provided by the federal government. As resources dwindle, health care expenditures and pension promises may increasingly crowd out spending on essential services, with implications for potential growth.

Treasury and Municipal Bond Yields
(percent)

Sources: Bloomberg; IMF staff calculations.
Note: Municipal bonds refer to the Bond Buyer 20-Bond Index, consisting of 20 general obligation bonds that mature in 20 years. The average rating of these bonds is equivalent to Moody's Aa2 and S&P's AA. Tax-equivalent yields are computed using the marginal tax rate on interest income from NBER's TAXSIM.

110.   **This chapter, relying on econometric analyses and case studies, seeks answers to the following questions**:

- How do state credit ratings and borrowing costs vary with unfunded pension and other post-employment benefit obligations?

- Do credit ratings and borrowing costs reflect the political and institutional characteristics of state legislatures?

111.   **The rest of the chapter is structured as follows**. We start with a brief discussion of the medium-term outlook and long-run challenges as well as the uncertainties surrounding them. Then we present the regression results and the case studies looking at the relationship between credit ratings and unfunded liabilities and the political and institutional characteristics of the state

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[91] http://www.standardandpoors.com/ratings/articles/en/us/?articleType=HTML&assetID=1245316529563.
[92] Such debt does not have to correspond to actual securities. Indeed, ratings agencies have recently started to combine outstanding market debt and unfunded retirement obligations into a single measure to assess the total financial burden on SLGs.

legislature. We conclude with a discussion of the policy implications emerging from the empirical analyses.
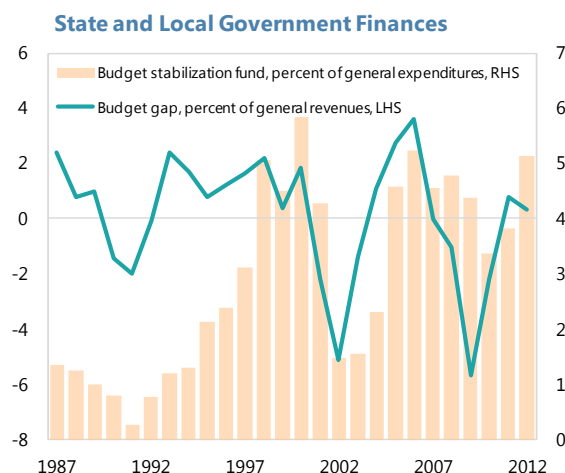
B.   Outlook and Risks: A Bird's Eye View

112.   **SLGs are in better shape than they were in the immediate aftermath of the Great Recession**. Tax receipts were hit hard by the recession and, even with the rainy-day funds providing some breathing room and the federal emergency funds mitigating some of the damage on the revenue side, difficult decisions had to be made to cut spending on education, health, transportation, and welfare. As tax receipts picked up with the ongoing economic recovery, SLG finances have improved and rainy day funds have been replenished (Chart).

State and Local Government Finances

Budget stabilization fund, percent of general expenditures, RHS

Budget gap, percent of general revenues, LHS

Sources: NASBO, Haver Analytics; IMF staff calculations.

113.   **With the cyclical rebound, the SLG fiscal drag on growth is expected to turn into an impulse in the near term**. Revenues are gradually recovering, but have not yet returned to pre-recession levels, and, hence, could have a further bounce-back barring a permanent loss in tax bases. As housing and labor market recoveries continue, tax receipts will rise while spending pressures related to the recession (e.g., unemployment benefits and welfare payments) will ease. These dynamics should give SLG consumption and gross investment enough room to start reverting back to their long-term averages.

114.   **Soon enough though, SLGs will have to address the structural challenges, most notably, public sector employee retirement plans and health care expenditures**.

- Public sector employee retirement plans: Many public sector employee pension plans are seriously underfunded and promises made under these plans may have to be reconsidered. But it is not even clear how large the funding needs are. The estimates are sensitive to actuarial assumptions and put unfunded liabilities in defined-benefit public pension plans somewhere between $¾ trillion and $3 trillion (Table). Moreover, legal protections under some state constitutions and political economy considerations make it difficult to take measures that would help reduce the funding gap. Finally, ongoing bankruptcy cases will set precedents as to the extent local governments can force various stakeholders to take haircuts.

How Large are Unfunded Pension Liabilities?

Study	Coverage	Investment Return (percent)	Funding Ratio (percent)	Unfunded Liability (billions of $)
Novy-Marx and Rauh (2009)	116 major pension plans sponsored by the 50 U.S. states as reported in their Comprehensive Annual Financial Reports	Treasury yield	38	3,230
Munnel et al (2010)	126 pension plans accounting for about 80 percent of the entire SLG retirement system	Alternative assumptions varying from 4 to 8 percent	between 48 and 79	between 700 and 2,900
Pew Charitable Trusts (as of April 8, 2014)	233 pension plans and 166 retiree health care and other benefit plans as reported in the states' Comprehensive Annual Financial Reports	states' own assumptions; most use 8 percent	72	915
Public Fund Survey Scorecard (as of May 16, 2014)	126 pension plans with the combined market value of system assets amounting to $2.63 trillion (85 percent of the entire SLG retirement system)	7.9	73	971

- Health care benefits for public sector retirees[93]: Although total unfunded liabilities for non-pension post-employment benefits are smaller in size at an estimated $600 billion and easier to address than pensions at least from a legal perspective, many states have not been adequately prepared to meet the commitments they have made under these programs. The average funding ratio across states is estimated to be less than 10 percent while only about 40 percent of required contributions are actually made. Moreover only three states (Alaska, Arizona, and Ohio) have other post-employment benefits funded at 50 percent or more because generally these benefits are funded on a pay-as-you-go basis.[94]

- Health care cost growth and the Affordable Care Act: Medicaid is a large spending category in state budgets (estimated to account for 20 percent in FY2012, ranking second after K-12 education) and enrollment in the program is expected to increase significantly in 2014 and thereafter as a consequence of the Affordable Care Act, but by how much remains to be seen. The Government Accountability Office (GAO) projects that SLG health care spending will increase by about 2 percentage points of GDP over the next two decades (about $350 billion in current dollars). Additional uncertainty comes from the difficulty in predicting how fast health care costs will rise in the future, including whether efforts to bend the cost curve will be successful or not.[95]

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[93] There may be other post-employment benefits but health care plans constitute the major portion. We use the terms health care benefits and other post-employment benefits interchangeably in the rest of the chapter.
[94] For comparison, 40 out of 50 states report pension funding of at least 60 percent.
[95] Chapter 3 of the IMF Country Report No. 13/237 looks at the factors driving health care spending growth and discusses the policy options to contain future health care spending.

115. **Other sources of risk surrounding the outlook for SLG finances include:**

- Fiscal policy uncertainty at the federal level: Uncertainty about federal fiscal policies translates into uncertainty at the SLG level. Moreover, fiscal consolidation at the federal government level has important consequences for SLGs. This is especially the case in places with closer ties to federal government activities (e.g., District of Columbia) and in places with greater reliance on federal grants (e.g., New Mexico).

- Reliance on procyclical taxation and shrinking tax bases: Over the last half century, SLGs have increasingly become more reliant on procyclical revenues, in particular personal income taxes (Table). Combined with balanced budget requirements and SLG responsibilities for social safety net expenditures, this trend has been manifested in larger and more volatile deficits. In addition, structural changes in the economy (e.g., shifting of consumption from goods to services and increase in cross-border activities) and some legislative actions (e.g., introduction of sales-tax holidays) have led to an erosion of the SLG tax bases. These trends will need to be addressed in order to avoid self-inflicted fiscal distress during recessions and to maintain the level and quality of essential services provided by SLGs.

	Reliance on Procyclical Taxes				
Year	General sales	Personal income	Property	Corporate income	Other
1950	21.1	9.1	49.6	7.4	12.8
1960	23.9	12.3	46.1	6.5	11.2
1970	29.6	19.2	34.7	7.8	8.7
1980	31.5	27.1	22.9	9.7	8.8
1990	33.2	32.0	19.8	7.2	7.8
2000	32.3	36.1	18.0	6.0	7.6
2010	31.9	33.6	21.9	5.2	7.4

Sources: Census Bureau; IMF staff calculations.
Note: Taxes are ordered based on the correlation between their growth rate and the gross state product growth.

- Options available at times of distress: Recent high-profile bankruptcy cases have reopened the question regarding what legal options are actually available to financially-distressed local governments and what different stakeholders should expect in the aftermath of a Chapter 9 filing (see Boxes 1 and 2; Appendix includes a partial list of recent bankruptcy cases). Political economy factors, including frameworks that would ensure timely and sound policy decisions even when the degree of political polarization is high, and relationships between a state government and local governments as well as those with the federal government, are also likely to come into play.
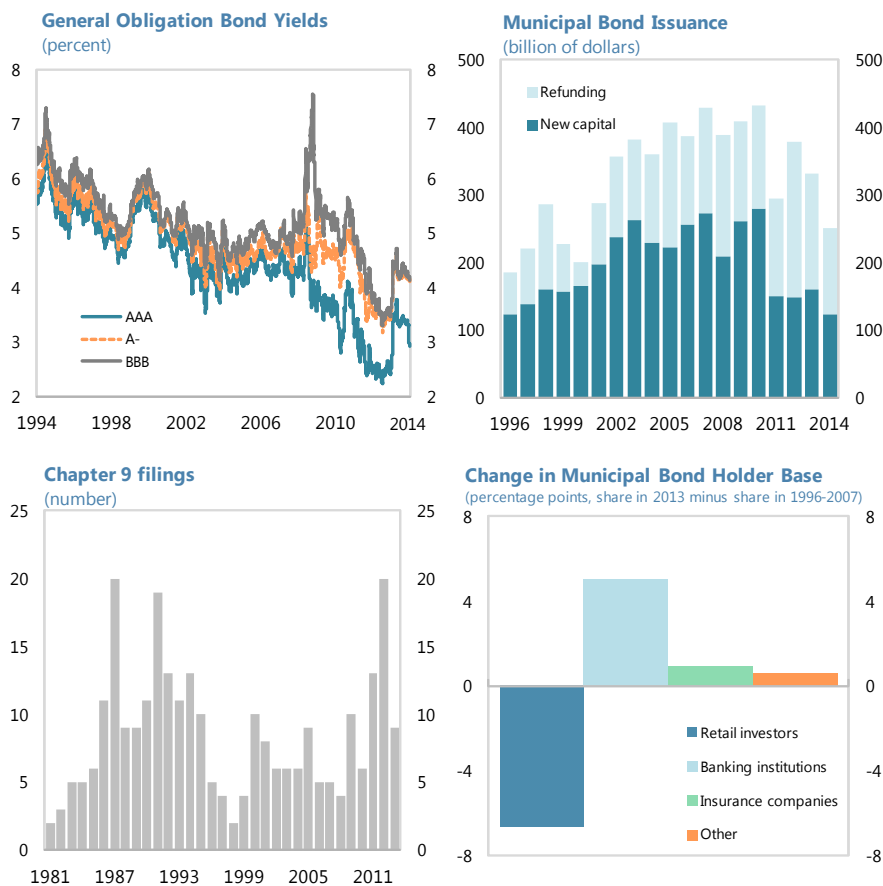
116. **Municipal bond market developments since the crisis in part reflect the increasing awareness of the challenges faced by SLGs**. Not only has the spread over the Treasuries widened (as mentioned in the Introduction), but also the spread between high-quality and low-quality municipal bonds have increased (Chart). While the Build America Bonds (BABs) have kept issuance levels at pre-crisis levels in 2009–10, issuance to raise new capital since the expiration of the BAB program has dropped to levels seen in the 1990s (in nominal terms).[96] Increased number of Chapter 9 filings and headline-grabbing distress stories (often citing unfunded pension liabilities), in addition to the anticipation of tapering by the Federal Reserve, led to a sell-off in 2013. The composition of the holder base has shifted from retail investors to banks and, to a much smaller extent, insurance companies and other investors, although retail investors continue to be the major group with more than two-thirds of the holdings.

Municipal Bond Market Developments

General Obligation Bond Yields
(percent)

Municipal Bond Issuance
(billion of dollars)

Chapter 9 filings
(number)

Change in Municipal Bond Holder Base
(percentage points, share in 2013 minus share in 1996-2007)

Sources: American Bankruptcy Institute; Bloomberg L.P.; Securities Industry and Financial Markets Association (SIFMA).

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[96] Established through the American Recovery and Reinvestment Act of 2009, the two-year BAB program authorized SLGs to issue special taxable bonds that received either a 35 percent direct federal subsidy to the borrower ("Direct Payment BABs") or a federal tax credit worth 35 percent of the interest owed to investors ("Tax Credit BABs"). BABs proved wildly popular, financing one-third of all new state and local long-term debt issuances from 2009 through the program's expiration in 2010. In total, the Joint Committee on Taxation (JCT) identified more than 2,275 separate bonds that were issued to finance $182 billion in new infrastructure investment, with participation from all 50 states, the District of Columbia, and two territories.

C. Empirical Analyses

Are They All in the Same Boat?

117.   **Aggregate statistics for SLGs mask a great degree of cross-sectional variation**. States, as well as local governments, have different economic, fiscal, and political risk characteristics and, these differences are reflected in the states' credit ratings and borrowing costs (Maps). For instance, North Dakota has enjoyed large budget surpluses even during the Great Recession in part thanks to strong economic activity driven by the shale gas boom. The state's credit rating was upgraded from AA in 2008 to AAA in 2013. Meanwhile, Arizona was hit hard by the housing boom-bust and struggled with budget deficits. Unsurprisingly, its credit rating was downgraded in 2010 from AA to AA-. The contrast between California and Pennsylvania on the one hand and North Carolina and Virginia on the other with respect to their debt levels also seems to be carried over to their credit ratings and bond spreads. The former two states are among the most heavily indebted and the lowest rated, and pay some of the highest borrowing costs. The latter two, in part thanks to their low debt levels, enjoy the low yields that come with their stellar AAA credit ratings. Similarly, liabilities related to public employee pensions and other post-employment benefits vary considerably across states. For example, with regard to pensions, Wisconsin has negligible unfunded liabilities with a pension plan that is 99.9 percent funded, while Illinois has very high unfunded liabilities (about 12 percent of gross state product) and the worst funding ratio in the nation at about 55 percent in 2010. High unfunded liabilities for pensions do not necessarily translate into high unfunded liabilities for other post-employment benefit plans. For example, Oklahoma has one of the highest unfunded pension liabilities as a percentage of gross state product at 10 percent but it has very small unfunded liabilities under its health care plan for public sector retirees. In terms of political polarization in state legislature, California ranks as one of the most polarized and Louisiana as one of the least.

Real Income Growth, 2010
(percent)

- (3.1,7.2]
- (1.8,3.1]
- (-1.7,1.8]
- [-1.7,-1.7]
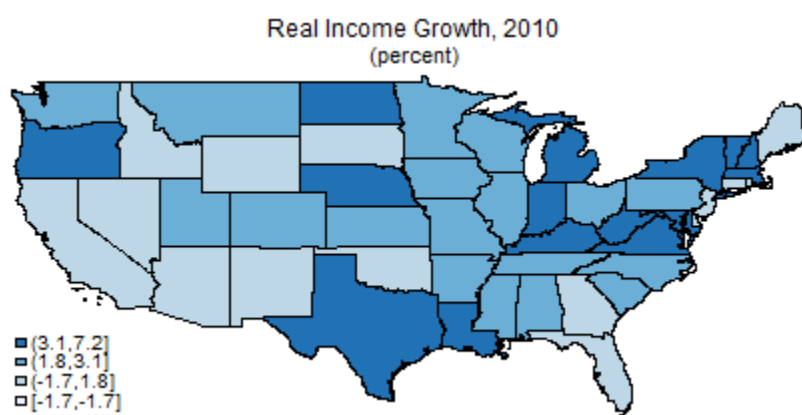
Market Value of Outstanding Bonds, 2010
(percent of GSP)

■ (21,28]
■ (21,21]
□ (18,21]
□ [7,18]
□ No data
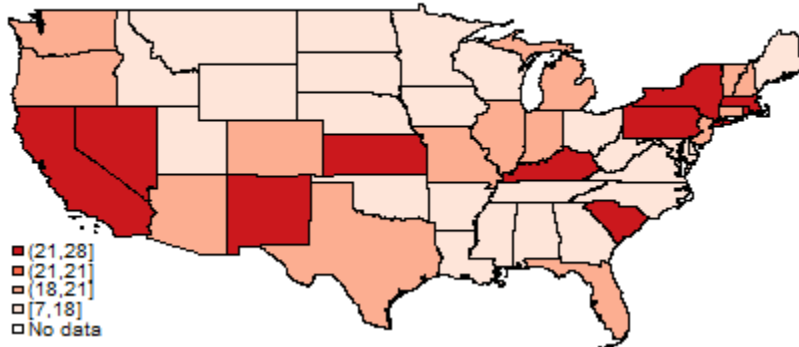
Unfunded Pension Liabilities, 2010
(percent of GSP)

■ (14,14]
■ (11,14]
□ (5,11]
□ [0,5]
□ No data
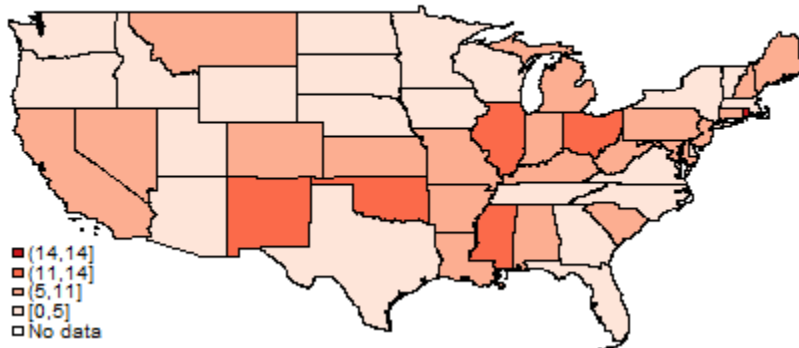
Unfunded Other Post-Employment Benefits, 2010
(percent of GSP)

■ (13,21]
■ (6,13]
□ (2,6]
□ [0,2]
□ No data
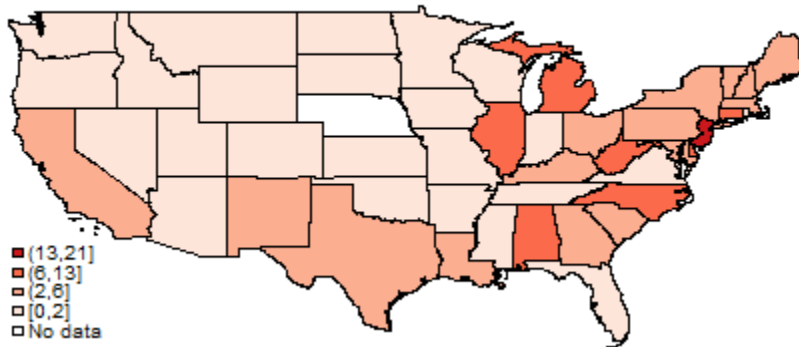
Political Polarization, 2010
(Shor & McCarthy, 2013; higher values indicate more polarized legislature)

■ (1.5,3.0]
■ (1.5,1.5]
□ (1.2,1.5]
□ [0.5,1.2]
□ No data

Credit Ratings, 2010
(S&P, AAA corresponds to a numerical value of 8)

□ (7,8]
□ (6,7]
□ [2,6]
□ No data

Municipal Bond Yields, 2010
(spread over Treasury bonds)

■ (1.0,1.5]
■ (0.3,1.0]
□ (0.0,0.3]
□ [-0.2,0.0]
□ No data

Econometric Setup and Findings

118.   **The baseline regression explores how credit ratings and municipal bond spreads relate to state economic and fiscal characteristics**.[97] We estimate the following equation using OLS:

$$\text{CR}_{it} = \alpha + \beta_1 UPL_{it-1} + \beta_2 UHL_{it-1} + \beta_3 DEBT_{it-1} + \beta_4 BBAL_{it-1} + \beta_5 IG_{it-1} + \beta_6 UR_{it-1} + \beta_7 TAX_{it} + \beta_8 POL_{it} + \gamma_t + \varepsilon_{it}$$

where *CR* is the credit rating (or bond spread, when available) for state *i* in year *t*. *UPL* and *UHL* stand for unfunded pension liabilities and unfunded other post-retirement benefits (mostly health care), respectively. *DEBT* and *BBAL* are the outstanding debt and the budget balance. The right-hand-side variables so far are all expressed in percent of the state's gross product (GSP). *IG* and *UR* are the real income growth and the employment rate, respectively. *TAX* is the tax rate applicable to the marginal investor. Finally, *POL* is a measure of political polarization in the state legislature. The regression results are summarized in the text table.

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[97] See Appendix for details of the econometric analyses.

119.   **We focus the discussion of the results mostly on the regressions where the dependent variable is the credit rating**. The findings for bond spreads are qualitatively similar to those for credit ratings but the sample size is much smaller and the relationships are often either not statistically significant or less robust to alternative specifications. As one would anticipate, spreads tend to be higher for lower-rated states (Chart). Hence, we use "borrowing costs" interchangeably with credit ratings when discussing the results.

Summary of Regression Results		
Variable	Rating	Spread
UPL	-	+
UHL	n.s.	n.s.
DEBT	-	+
BBAL	+	-
IG	n.s.	n.s.
UR	n.s.	+
TAX	-	n.s.
POL	-	n.s.

Sign of the coefficient obtained in the regressions for each variable is shown.

120.   **Not surprisingly, state credit ratings are negatively correlated with debt levels**. Econometric analysis exploiting the variation across states reveals that states with higher levels of debt (in percent of gross state product) have lower credit ratings. As expected, budget surpluses and lower marginal taxes are also associated with better ratings. Links with income growth and unemployment rate are not statistically significant.
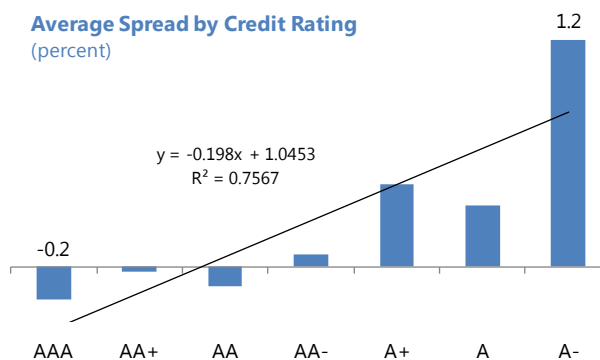

Average Spread by Credit Rating
(percent)

$y = -0.198x + 1.0453$
$R^2 = 0.7567$

121.   **Increased awareness about unfunded pension liabilities appears to be reflected in the ratings**. States with larger unfunded pension liabilities have lower credit ratings and face higher borrowing costs. Interestingly, unfunded liabilities under health care and other benefits, which are not only smaller and but also received much less attention than pensions, are negatively related to credit ratings but this relationship loses significance when unfunded pension liabilities are also included in the regression. Also noteworthy is the fact that unfunded liabilities in the regressions are as reported by the states themselves, that is, likely assuming more generous rates of return. Under more prudent return assumptions, these liabilities would be larger—and upward revisions to unfunded liability estimates are indeed expected to take place once the recent change to the Governmental Accounting Standards Board (GASB) rules is fully implemented.[98]

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[98] Unlike private pension systems, which are governed by federal law and regulations, state and local pension plans are not required to follow specific methods in calculating funding adequacy. Most plans adhere to the guidelines issued by the GASB but the board has no enforcement authority. Moreover, until June 2012, GASB rules allowed plans to use discount rates based on the expected rates of return, typically around 8 percent, to calculate pension liabilities and determine the degree of underfunding. The high discount rate underestimates the present value of promised benefits, which should instead be discounted by the riskless rate of return because these payments are certain to be made. With the rule change, the high discount rate can be used only for the funded portion of pension liabilities (i.e., the part backed by underlying pension assets) and the rest has to be discounted using a riskless discount rate, leading to a funding ratio that would be some 20 percentage points below the one estimated under the old rule.

122.   **Political polarization has some bearing on market perceptions of a state's creditworthiness as well**. States with less polarized legislatures tend to have higher ratings. This is likely to reflect uncertainty pertaining to fiscal policies and the propensity for fiscal showdowns.

123.   **Budget institutions also relate to borrowing costs**. This relationship is, however, more difficult to detect in econometric specifications, perhaps due to the fact that these variables have relatively higher degree of persistence within a state. Still, there is some regularity when the sample is split based on certain budget practices, suggesting that good budget institutions can mitigate the adverse effects of low funding ratios, high outstanding debt levels, and high degrees of polarization in local politics. In particular, unfunded post-employment benefit liabilities are priced in the state credit ratings if budget deficits are allowed to be carried over, if there is a supermajority requirement to pass revenue increases, and if there are caps on rainy day funds (Chart).[99]

Credit Ratings, Challenges, and Budget Institutions
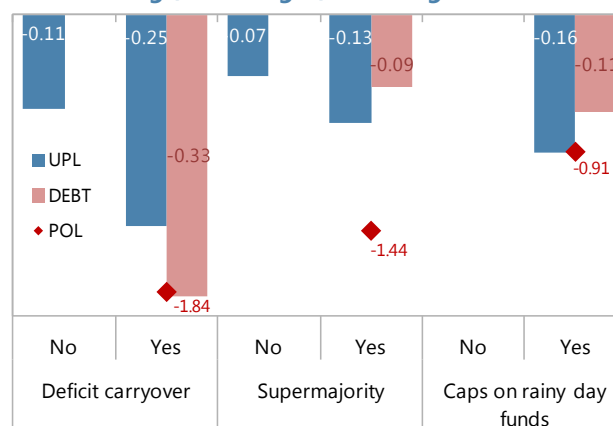
Source: IMF staff estimates.
Note: The bars show the magnitude of the coefficient on unfunded pension liabilities (UPL), outstanding debt (DEBT), and political polarization (POL) when the sample is split based on a budget institution indicator. Dependent variable is the credit rating. Only statistically significant coefficients are shown. The differences between coefficients obtained in the subsamples are also statistically significant.

124.   **Teasing out robust, causal relationships is a difficult task and several caveats should be taken into account when interpreting these findings**. Given that many of the variables of interest change minimally from one year to the next in the same state, introducing state fixed effects in the regression equation is problematic and, hence, any correlation may well be driven by some omitted state characteristic. Another issue is related to the measurement of borrowing costs: municipal bond markets are loosely-regulated, decentralized, over-the-counter markets.[100] That is why we primarily focus on credit ratings. Reverse causality is also a problem as states may take actions to improve indicators of fiscal health in response to a ratings downgrade and a rise in borrowing costs. Therefore, the results of the econometric analyses should be taken with a grain of salt.

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[99] Tests confirm that the coefficients obtained in the subsamples based on a budget institution indicator are statistically different from each other. These results are further confirmed when the difference between the actual and the predicted credit rating is regressed on budget institution indicators.

[100] Municipal bond markets have been given generous exemptions under the Securities Act of 1933 and the Securities Exchange Act of 1934, except for antifraud cases. A limited regulatory scheme requiring dealers to register with the Securities Exchange Commission (SEC) and giving Municipal Securities Rulemaking Board (MSRB) authority to issue rules governing trades was introduced under the Securities Acts Amendments of 1975, but the "Tower Amendment" kept issuers exempt from requirements to file any presale documents. The Dodd-Frank Act expanded the MSRB's authority and brought municipal advisors into the regulatory circle, but did not change the provisions applicable to issuers. Concerns about timeliness and comparability of financial information, lack of disclosure by conduit borrowers, adequacy and accuracy of disclosure regarding funding obligations under pension and other post-retirement benefits, and the illiquid, opaque, and fragmented market microstructure make it particularly difficult to construct bond yields at the state level and extract information from these series.

Case Studies

125.   **The importance of sound fiscal policies and budget institutions can be further illustrated with case studies**. Regression analyses shed light into the role played by budget outcomes, unfunded pension liabilities, and political polarization in municipal bond markets and hinted at the interactions with institutional characteristics. Nonetheless, given the lack of variation in some of the variables used, we use case studies to complement this evidence (especially that on the role of budget institutions). We look at the experience of four states where the credit rating is much higher or lower than that implied by the "fundamentals".[101] Good news is that blemished credit can be fixed and market pressures can be alleviated when necessary actions are taken (also see Box 2 on Detroit and Puerto Rico).

Alaska

126.   **Alaska demonstrates how flexible yet conservative budget institutions can help offset the impact of moderately high liability levels**. Alaska has an inherent vulnerability due to its economy's dependence on the natural resource industry. To mitigate the volatility induced by energy-related revenues, the state has set aside very large reserves for general fund operating needs (principally in the Constitutional Budget Reserve Fund and the Statutory Budget Reserve Fund). There are no caps on these funds and repayment provisions are flexible in that there is no fixed time limit to replenish the reserves. Moreover, Alaska projects revenues for a ten-year window—at least twice longer than any other state. Although the funding ratios of major statewide pension systems are weak at about 55 percent compared to the national average of 70 percent, Alaska has kept up with its contributions and taken steps to address the issue, including closing of defined benefit plans to new employees in 2005. These actions seem to have helped maintain the state's AA+ rating in 2010 despite a budget deficit of almost 3 percent of GSP and get an upgrade to AAA in 2012.

California

127.   **California exemplifies how markets reward active deficit reduction and improvement in budget institutions**. Faced with immediate liquidity pressures as the deficit soared in the aftermath of the dot-com boom, California enacted Proposition 57 and 58 in 2004, authorizing issuance of long-term bonds to pay off accumulated deficits. However, they also prohibited any future deficit bonds and required enactment of a balanced budget and the establishment of a budget stabilization account. As a result, the state got a three-notch boost in its bond rating from BBB to A. The state's effort to balance its general fund budget through tax hikes enacted in 2012 also led to a ratings upgrade while its revenue-anticipation notes issued in August 2013 had the lowest yields since the 1970s. But California's current rating of A is still about two notches below

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[101] Specifically, we use the estimated coefficients to predict the credit rating for each state based on their economic, fiscal, and political characteristics. The four states chosen have the largest differences between the actual and predicted credit ratings consistently (that is, not only in a single year but consecutively over a three-year period).

what one would expect based on its fundamentals, especially considering its relatively small unfunded pension liabilities. Instead, it seems that remaining weaknesses in budget institutions—including the ability to spend unanticipated funds without legislative approval, the scope to carry over deficits, and the supermajority requirement for revenue increases—have weighed on California's credit rating.

Illinois

128.   **Illinois shows how inaction to correct imbalances and adopt good budget institutions can calcify into a bad reputation and translate to higher borrowing costs**. Illinois currently has the lowest credit rating across U.S. states at A-, although the econometric model would predict three notches higher. The state was not always at the bottom: actually, Illinois and Alaska had the same rating as late as 2007. However, several decades of skipping or skimping on payments for the required contributions to pension plans resulted in the state having the worst funding ratio (at about 40 percent) in the nation. While all other states that faced similar challenges have taken some sort of action, Illinois became known for its political gridlocks and repeated failures to deliver on pension reform. Moreover, a budget stabilization fund was introduced in 2000—Illinois was one of only five states that did not have one at the time—but design flaws led to the fund being used for the alleviation of ongoing cash flow problems rather than for fiscal emergencies. These factors have produced what has become known as the "Illinois effect," whereby similarly structured and rated municipal bonds carry higher interest rates if the issuer is located in Illinois.

New Jersey

129.   **New Jersey confirms that failing to address structural imbalances and implement sound fiscal management practices can hurt creditworthiness**. With a volatile income tax base heavily dependent on a small number of high-income residents, the state had difficulty meeting the challenges posed by the Great Recession, and was forced to make deep cuts in school funding and aid to local governments. The latter, in turn, were forced to raise property taxes. The state has underpaid its pension contributions for years, even before the recession started and made only 14 percent of the required pension contributions in 2012 after failing to make any payments in 2010 and 2011. Overly optimistic revenue forecasts spanning only one year coupled with one-off moves to plug annual deficits rather than implementation of permanent solutions are all factors that have raised concerns about budget processes. In addition, liquidity has become a concern as rainy day funds, drained in 2009, have not been replenished. The state's credit rating has been downgraded three times from AA+ in 2002 to A+ in 2014.

D. Policy Implications

130.   **There are important challenges facing SLGs on the horizon**. Problems such as rising health care costs and underfunding of promises made under public employee benefit plans mean that tough choices will have to be made if SLGs are to avoid large cutbacks to other essential functions, such as in education and infrastructure investment. Moreover, federal government consolidation efforts will reduce financial resources potentially available to SLGs. The significant

fiscal adjustment in the past few years has improved fiscal balances, but this should not give a false sense of safety. SLGs will have to tackle the ticking time bombs of public sector employee retirement and health care plans soon. Many states have enacted reforms in this area recently but these tend to remain on the margin and be limited to new hires only (see Appendix for a partial list of recent pension reform actions).

131.   **Empirical analyses point to unfunded pension liabilities being associated with lower credit ratings, especially when budget institutions are weak**. If left unchecked, these liabilities will continue to grow as the population ages and may increase borrowing costs. Moreover, such implicit liabilities are likely to weigh on credit risks with potential to raise financing costs and weaken SLG finances more broadly.

132.   **In order to keep future borrowing costs in check, SLGs should**:

- assess the extent of their unfunded liabilities under more realistic actuarial assumptions, move away from defined-benefit plans, pursue reforms as necessary to ensure fiscal health, enhance risk sharing, and establish separately-governed trust funds if they choose to maintain pay-as-you-go financing[102];

- improve their budget frameworks, including adoption of multi-year plans laying out conservative revenue forecasts, better enforcement of balanced budget rules and rules governing the use of unanticipated funds, and introduction of more flexible revenue-increase and rainy-day fund rules.

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[102] The new GASB rules take steps in this direction by requiring more realistic appraisal of the unfunded portion of pension obligations as well as higher required contributions and more transparency in the reporting of obligations.

Box 1. Legal Options Available to Financially Distressed Local Governments

Aside from undertaking a voluntary, out-of-court debt workout, legal options for a financially distressed local government to reduce, extend, and/or restructure outstanding debts are limited. Moreover, uncertainties surrounding privileged debt render outcomes unpredictable, regardless of the restructuring scenario.

Some—but not all—local governments may be eligible to seek protection under Chapter 9 of the U.S. Bankruptcy Code. As a general matter, the U.S. Constitution allocates powers to the federal government but preserves State sovereignty in accordance with the Tenth Amendment. Thus, while bankruptcies are carried out exclusively in federal courts under the U.S. Bankruptcy Code, its application to the States is carefully circumscribed. Eligible debtors under the Bankruptcy Code include local governments, but not States. For a local government to file a bankruptcy petition, in addition to other preconditions, it must obtain State approval. Many States limit which entities can file and under what circumstances. Even when the Bankruptcy Code does apply, the court's powers over the operations of the local government are limited. For example, the court could not direct the local government to sell assets nor could it appoint a trustee or receiver to oversee its affairs. Local legislation may empower a State to exercise this type of control, in tandem with, or independently from, federal bankruptcy proceedings. For example, the State of Michigan appointed an emergency manager to Detroit before bankruptcy proceedings commenced, and has continued to exercise this authority throughout the bankruptcy proceedings.

Currently, the U.S. Bankruptcy Code does not apply to the Commonwealth of Puerto Rico (or the District of Columbia). In contrast to States where sovereignty is constitutionally protected, Congress retains full legislative control over U.S. territories, including Puerto Rico. Such powers would allow Congress to intervene prior to default (for example, to impose tighter fiscal controls) or post default (for example, to amend the U.S. Bankruptcy Code to ensure its application or to create a special insolvency procedure). As a matter of policy, however, several factors would likely influence a decisive exercise of this authority, including whether doing so would impose a burden on U.S. taxpayers more broadly or unduly undermine the historical local self-governance enjoyed by Puerto Rico.

Under any restructuring scenario, a key issue will be ascertaining the extent to which debt incurred by the local government is privileged. In particular:

- State constitutions and local labor laws may place restrictions on the ability of the local government to restructure public employee and retiree benefit plans. While this could serve as an impediment to a debt workout, the Bankruptcy Code generally allows a municipal debtor to adjust or eliminate these obligations. However, there may public policy reasons to limit the scope of such adjustments, which would need to be balanced against the Bankruptcy Code's requirement to ensure that similarly situated creditors (i.e., other unsecured creditors) are treated in a fair and equitable manner.

- State constitutions and local law may grant privileges to certain bondholders, and thus the treatment of general obligation bonds across the States and territories may not be uniform. General obligation bonds, which are backed by general tax revenues and the "full faith and credit" of the issuing entity are presumed to be unsecured debt, unless State laws provides otherwise. California legislation, for example, establishes a lien in favor of general obligation bondholders; this is not the case in Michigan. Also, the Puerto Rican Constitution provides that the public debt of the Commonwealth, constitutes a first claim on available resources and empowers bondholders, to bring suit to require application of available resources to the payment of principal of, and interest on, public debt when due.

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Box 2. 2013 Municipal Bond Market Distress

Recent high-profile cases of financial distress have brought U.S. municipal bond markets and the state of SLG finances to the spotlight. In the largest U.S. municipal bankruptcy ever, the city of Detroit filed for bankruptcy on July 18, 2013, while yields on Puerto Rican bonds have soared in the fall of 2013 on concerns of the island's debt sustainability. Considerable uncertainty remains, also reflecting uncharted legal questions raised by these episodes.

Detroit's bankruptcy filing occurred after decades of decline due to a depressed local economy (severely affected by the scaling down of local auto industry employment), declining tax revenues (driven by falling house prices and population loss, especially in higher-income segments), and deteriorating quality of city services. The bankruptcy was highly anticipated and already priced in. Yields on 10-year benchmark municipal bonds rose by 15 basis points between July 18 and July 25 before receding. They stood at 2.3 percent on June 17 [lower than the July 18, 2013 level of 2.66 percent]. The legal process will take a long time. Currently, the goal is to finish the process by early fall 2014. Along the way, important precedents may be set at least in two main areas.[1]

- There is a legal gray area on how public pensions will be treated. Michigan is one of nine states that explicitly protect public employee pensions in the state constitution but, under the federal bankruptcy law, a judge may be able to subvert the state constitution to reduce the Detroit's obligation to its pensioners. A legal battle is expected, perhaps ultimately reaching the Supreme Court.

- The haircut the bondholders would take under Detroit's restructuring proposals is generally higher than what the market currently assumes for loss-given-default in municipal bankruptcies. Re-pricing risk across the municipal market cannot be ruled out if Detroit is successful in negotiating higher haircuts.

Highly dependent on federal aid and tax incentives, Puerto Rico has been in recession since 2006, when the phase-out of an important tax credit was completed. The recession exposed long-standing structural problems. These include high public debt ($70 billion, around 100 percent of GDP); heavy government involvement financed by subsidized debt (Puerto Rican bonds are "triple-tax-free," meaning that they are exempt from federal, state, and local taxes, and the government sector accounts for 27 percent of total nonfarm employment); and lack of competitiveness, in part because of high labor costs relative to Caribbean neighbors (the U.S. federal minimum wage applies in Puerto Rico) and a low labor force participation rate (emigration to the mainland is common and residents often qualify for direct transfers from the U.S. federal government).

Doubts about Puerto Rico's debt sustainability surfaced in the summer of 2012 and intensified in the fall of 2013. The island's increasing reliance on bank credit and other short-term measures to fund budget gaps came into the spotlight against the backdrop of a struggling economy. The government unveiled plans—including pension reform, tax hikes, spending cuts, a balanced budget proposal, and incentives to attract businesses to the island—to address the problems but flows out of Puerto Rican debt continued. In February 2014, all three major credit rating agencies downgraded Puerto Rico to junk status. Paradoxically, Puerto Rican debt rallied after the downgrade, thanks to the removal of uncertainty regarding credit rating agency action and the island was able to raise $3.5 billion in bond sales in March. Yields on 10-year Puerto Rican bonds stood at 8.8 percent on June 17, up from 6.2 percent at the end of August 2013 but down from above 10 percent observed in early late January/early February. Moreover, Puerto Rico was able to tap the markets and raise $3.5 billion in general obligation bonds in March 2014.

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Box 2. 2013 Municipal Bond Market Distress (Continued)

Unlike Detroit, Puerto Rico cannot file for bankruptcy under Chapter 9. With the standard bankruptcy procedure off the table, a potential default would fall in the legal twilight zone and set new precedents. Some of the issues highlighted above for Detroit also apply to Puerto Rico, but the fact that the island is not eligible to file for bankruptcy under current law further complicates the legal questions (see Box 1).

While these cases may set precedents on a range of legal matters regarding municipal bond distress and create some ripple effects, there is little risk of immediate contagion and a negative systemic impact. Historically, municipal bankruptcies have been rare and idiosyncratic, and recovery rates have been close to 100 percent even in the case of default—and default rates are much lower than comparable corporate bonds (Table). Indeed, Arezki, Candelon, and Sy (2011) find that an increase in financing costs of a state results in more favorable borrowing conditions for other states, perhaps reflecting the captive municipal bond demand in retail investor portfolios and consistent with the widening of spreads between high- and low-quality municipal bonds documented in Section B. Limited exposure by foreign investors given that they cannot take advantage of the tax-exempt status of these bonds should reduce the potential spillovers to international markets.

Default Rates		
S&P rating	Munis	Corps
AAA	0.00	0.60
AA	0.00	1.50
A	0.23	2.91
BBB	0.32	10.29
BB	1.74	29.93
B	8.48	53.72
CCC-C	44.81	69.19
Investment grade	0.20	4.14
Non-investment grade	7.37	42.35
All	0.29	12.98

Historical default rates for municipal and corporate bonds rated by Standard & Poor's. Cumulative default rates up to 2007 expressed in percent.

Detroit and Puerto Rico experiences have, so far, continued to demonstrate that individual municipal bankruptcy and distress cases do not generate waves of defaults. Detroit's estimated $18.5 billion in liabilities (nearly half of which are for retiree benefits) are small relative to the $3.7 trillion size of the U.S. municipal bond market. Puerto Rico arguably poses a bigger risk. An estimated 75 percent of mutual funds have exposure to Puerto Rico. Disclosures by UBS and Citigroup (the top two under-writers of Puerto Rican debt) suggest that spillovers may occur since Puerto Rican debt is used as collateral. That said, damage may still be contained and there is no obvious trigger event that would lead to a Puerto Rican default. Even with debt at three times that of Detroit, Puerto Rico is less than 2 percent of the municipal bond market and other municipal issuers are in much better shape than they were only a few years back.

[1] Early in the bankruptcy process, the emergency financial manager of Detroit proposed to classify all general obligation (GO) bonds as unsecured debt, leading creditors to argue that the city had a statutory requirement to levy taxes as necessary and segregate certain tax proceed to pay for a particular class of GO bonds. This classification proposal, which would have had important ramifications for creditor rights in the municipal bond market, has since been dropped from the debt restructuring proposal.

Appendix 1. Details on the Econometric Analyses and Recent Developments

The econometric specification we use to examine the relationship between municipal bond market's perception of a state's creditworthiness and state characteristics builds the list of variables to include based on the analyses in Bayoumi, Goldstein, and Woglom (1995), Poterba and Reuben (1999), Novy-Marx and Rauh (2009b), and Grizzle (2010).

Data come from a variety of sources including Bloomberg, Bureau of Labor Statistics, Census Bureau, National Association of State Budget Officers, Pew Center, and NBER TAXSIM. Sample period covers 2008 through 2014.

We present the results under two main specifications: first with the credit rating as the dependent variable and then with the bond spread as the dependent variable. The latter is available only for 19 states (and Puerto Rico but Puerto Rico is not included in the regressions because of missing information on some of the control variables). The baseline regression results are in Tables 1 and 2.

These results are robust to several changes to the specification including addition of other macroeconomic and fiscal controls (such as log level of state per capita income, revenue-to-GSP ratio, and average growth rate of revenues in the last three years) and different lags of the control variables.

An obvious concern is the endogeneity of outstanding debt levels. If a state is perceived to be in better fiscal health (e.g., because of its economic potential or because it has better budget institutions) and faces lower borrowing costs, it may opt for higher levels of debt because it can afford to do so. To address this concern and check the robustness of the coefficients on unfunded pension and other post-employment benefit liabilities and political polarization, we use an instrumental variables approach. Noting that most general obligation debt is long term and issued to finance infrastructure spending, the instrument we use is the population density of the state: more densely populated states tend to have higher demand for infrastructure and, hence, higher debt levels but population density is not related to credit ratings or bond yields. The instrumental variable regression results are in Table 3. First-stage results (available upon request) confirm the suitability of population density as an instrument for outstanding debt level. The main coefficients of interest on unfunded pension liabilities and political polarization remain largely unaltered in the IV regressions while the coefficient on outstanding debt is no longer significant. The latter may be an indication that the municipal bond market does take into account the fact that most debt is issued to finance capital projects with potential to benefit long-term growth.

Finally, Tables 4 and 5 provide a partial list of recent municipal bankruptcy filings and pension reform actions.

Table 1. Determinants of State Credit Ratings

	Full sample			Before 2010			After 2010		
UPL	-0.101***		-0.098***	-0.077***		-0.079***	-0.119***		-0.112***
	[0.019]		[0.018]	[0.027]		[0.029]	[0.024]		[0.024]
UHL		-0.039**	-0.018		-0.033	-0.019		-0.049***	-0.029
		[0.016]	[0.017]		[0.021]	[0.020]		[0.016]	[0.018]
DEBT	-0.083***	-0.094***	-0.080***	-0.077***	-0.080***	-0.073***	-0.084***	-0.102***	-0.081***
	[0.011]	[0.014]	[0.011]	[0.020]	[0.023]	[0.021]	[0.013]	[0.018]	[0.013]
BBAL	0.322**	0.258**	0.322**	0.039	0.037	-0.01	0.424***	0.298***	0.441***
	[0.143]	[0.115]	[0.153]	[0.248]	[0.264]	[0.270]	[0.144]	[0.113]	[0.163]
IG	-0.018	-0.009	-0.017	-0.002	-0.015	-0.005	-0.034	0.006	-0.041
	[0.034]	[0.034]	[0.037]	[0.047]	[0.051]	[0.049]	[0.039]	[0.040]	[0.040]
UR	-0.051	-0.075*	-0.054	0.014	-0.032	-0.012	-0.073*	-0.090*	-0.068
	[0.035]	[0.040]	[0.037]	[0.076]	[0.083]	[0.079]	[0.041]	[0.048]	[0.045]
TAX	-0.090***	-0.088***	-0.084***	-0.06	-0.064	-0.052	-0.095***	-0.091***	-0.084**
	[0.026]	[0.028]	[0.029]	[0.047]	[0.049]	[0.048]	[0.032]	[0.034]	[0.036]
POL	-0.484**	-0.405**	-0.520***	-0.479	-0.457	-0.559	-0.482**	-0.397*	-0.521**
	[0.190]	[0.203]	[0.198]	[0.389]	[0.395]	[0.396]	[0.219]	[0.239]	[0.227]
Cons	10.036***	9.856***	10.088***	9.087***	9.215***	9.381***	10.472***	10.165***	10.455***
	[0.481]	[0.502]	[0.512]	[1.081]	[1.110]	[1.127]	[0.548]	[0.572]	[0.592]
Obs	290	284	284	100	98	98	190	186	186
R-squared	0.35	0.29	0.35	0.20	0.18	0.22	0.43	0.34	0.43

Notes: The sample consists of 50 states. The credit rating is the Standard & Poor's rating of a state's general obligation bonds. UPL stands for unfunded pension liabilities, UHL stands for unfunded retiree health benefits, DEBT is the market value of a state's outstanding bonds, BBAL is the budget balance. UPL, UHL, DEBT, and BBAL are expressed as percent of gross state product and lagged by one year. IG is real income growth over the previous year. UR is the unemployment rate in the previous year. TAX is the top marginal tax rate on interest income (source: TAXSIM). POL is a measure of political polarization in the state legislature (source: Shor and McCarthy, 2013).

Table 2. Determinants of Municipal Bond Spreads

	Full sample			Before 2010			After 2010		
UPL	0.032***		0.035***	0.011		0.011	0.042***		0.046***
	[0.010]		[0.011]	[0.010]		[0.011]	[0.012]		[0.013]
UHL		0.002	-0.009		0.002	-0.001		-0.002	-0.018
		[0.007]	[0.009]		[0.008]	[0.010]		[0.010]	[0.013]
DEBT	0.030***	0.029***	0.029***	0.039***	0.038***	0.038***	0.025***	0.025**	0.025***
	[0.004]	[0.006]	[0.005]	[0.006]	[0.006]	[0.006]	[0.006]	[0.010]	[0.006]
BBAL	-0.434***	-0.433***	-0.460***	-0.367***	-0.371**	-0.369**	-0.733***	-0.691**	-0.801***
	[0.144]	[0.155]	[0.148]	[0.130]	[0.138]	[0.136]	[0.271]	[0.310]	[0.271]
IG	-0.008	-0.014	-0.007	-0.016	-0.016	-0.016	0.043	0.027	0.053
	[0.017]	[0.016]	[0.018]	[0.025]	[0.026]	[0.025]	[0.037]	[0.039]	[0.039]
UR	0.045**	0.060**	0.055**	0.037	0.042	0.038	0.046**	0.070**	0.067**
	[0.018]	[0.028]	[0.025]	[0.038]	[0.046]	[0.043]	[0.020]	[0.035]	[0.029]
TAX	-0.015*	-0.009	-0.012	-0.009	-0.008	-0.009	-0.008	0.001	0.001
	[0.008]	[0.011]	[0.010]	[0.016]	[0.018]	[0.018]	[0.011]	[0.017]	[0.013]
POL	0.138	0.069	0.113	0.375***	0.353**	0.372***	-0.056	-0.142	-0.118
	[0.087]	[0.120]	[0.098]	[0.119]	[0.136]	[0.128]	[0.108]	[0.178]	[0.129]
Cons	-0.772***	-0.651***	-0.789***	-1.312***	-1.281***	-1.311***	-0.509**	-0.356	-0.570**
	[0.216]	[0.208]	[0.225]	[0.360]	[0.343]	[0.363]	[0.244]	[0.245]	[0.272]
Obs	112	112	112	38	38	38	74	74	74
R-squared	0.53	0.44	0.53	0.69	0.68	0.69	0.52	0.36	0.54

Notes: The sample consists of 19 states. The municipal bond spread is calculated as the difference between the yield on a state's general obligation bonds, as reported by Bloomberg, and the 10-year Treasury bond yield. UPL stands for unfunded pension liabilities, UHL stands for unfunded retiree health benefits, DEBT is the market value of a state's outstanding bonds, BBAL is the budget balance. UPL, UHL, DEBT, and BBAL are expressed as percent of gross state product and lagged by one year. IG is real income growth over the previous year. UR is the unemployment rate in the previous year. TAX is the top marginal tax rate on interest income (source: TAXSIM). POL is a measure of political polarization in the state legislature (source: Shor and McCarthy, 2013).

Table 3. Instrumental Variable Estimates

DV -->	Credit Rating			Municipal Bond Spread		
UPL	-0.104***		-0.104***	0.030**		0.034***
	[0.023]		[0.024]	[0.012]		[0.011]
UHL		-0.050***	-0.021		0	-0.012
		[0.018]	[0.018]		[0.008]	[0.010]
DEBT	-0.069	-0.016	-0.047	-0.028	0.013	0.002
	[0.060]	[0.067]	[0.062]	[0.049]	[0.025]	[0.025]
BBAL	0.322**	0.245**	0.320**	-0.464***	-0.444***	-0.481***
	[0.137]	[0.101]	[0.146]	[0.176]	[0.157]	[0.150]
IG	-0.02	-0.016	-0.02	0.007	-0.01	0.001
	[0.033]	[0.033]	[0.037]	[0.028]	[0.020]	[0.022]
UR	-0.065	-0.156*	-0.087	0.094*	0.075*	0.080*
	[0.065]	[0.085]	[0.070]	[0.056]	[0.045]	[0.042]
TAX	-0.090***	-0.083***	-0.082***	-0.027*	-0.011	-0.016
	[0.026]	[0.027]	[0.029]	[0.016]	[0.010]	[0.011]
POL	-0.481**	-0.388*	-0.521***	0.002	0.029	0.043
	[0.189]	[0.209]	[0.194]	[0.186]	[0.166]	[0.144]
Cons	9.953***	9.031***	9.807***	0.113	-0.419	-0.427
	[0.795]	[0.875]	[0.796]	[0.803]	[0.452]	[0.436]
Obs	290	284	284	112	112	112
R-squared	0.35	0.23	0.34	0.18	0.42	0.46

Notes: Population density is used as an instrument for the debt level because most long-term general obligation bonds are issued to meet infrastructure needs. The credit rating is the Standard & Poor's rating of a state's general obligation bonds. The municipal bond spread is calculated as the difference between the yield on a state's general obligation bonds, as reported by Bloomberg, and the 10-year Treasury bond yield. UPL stands for unfunded pension liabilities, UHL stands for unfunded retiree health benefits, DEBT is the market value of a state's outstanding bonds, and BBAL is the budget balance. UPL, UHL, DEBT, and BBAL are expressed as percent of gross state product and lagged by one year. IG is real income growth over the previous year. UR is the unemployment rate in the previous year. TAX is the top marginal tax rate on interest income (source: TAXSIM). POL is a measure of political polarization in the state legislature (source: Shor and McCarthy, 2013).

Table 4. Recent Municipal Bankruptcies

Date	City, State	Reason/Amount
2008	Gould, Arkansas	Municipality filed a chapter 9 case as a strategy **to forestall several lawsuits.**Case was dismissed after debtor regained financial stability.
2008	Vallejo, California	**Pension obligations and operational budget;** Financial distress stemmed mainly from the city's inability to pay pension benefits to government employees.
2009	Westfall Township, Pennsylvania	**Debt or payments related to public services or owed to private litigants.** Filed a chapter 9 case in the face significant debts resulting from a $20.8 million decision in favor of a resident who had sued the municipality after the township had sought to prevent the resident from building a housing development.
2009	Washington Park, Illinois	**Debt or payments related to public services or owed to private litigants**. Washington Park, Illinois filed a chapter 9 case due in part to mounting payments owed to trash collectors. Washington Park's debts also stem from litigation brought by private citizens, including litigation brought by a private strip club that resulted in the city being unable to continue to realize significant annual revenue from strip club licenses and becoming liable for the strip club's attorneys fees. The municipality has also faced litigation related to certain government employees' corrupt practices.
2009	Prichard, Alabama	**Pension obligations and operational budget;** The municipality was under significant financial pressure regarding its operational budget and its pension reserves for retired government employees. It was able to revise its budget, so that it would no longer operate at a deficit, but it could not come up with the funds to pay its pension obligations. In the face of litigation from retirees, the municipality filed a chapter 9 case.
2011	Central Falls, Rhode Island	**Pension obligations and operational budget**; Owed more than $80 million in unfunfed pension and retiree health benefit liability.
2011	Harrisburg, Pennsylvania	**Debt or payments related to construction of facilities for public services;** chapter 9 filing, due largely to $282 million of debt associated with the construction of a trash incinerator.
2011	Jefferson County, Alabama	**Debt or payments related to construction of facilities for public services.** $3 billion in sewer debt.The "sewer debt" was further exacerbated by an interest rate swap transaction that failed.
2012	Stockton, California	**Pension obligations and operational budget;** Unable to meet financial obligations; $319m in outstanding debt, plus $450m in health insurance and pension liabilities for city retirees.
2012	San Bernardino, California	**Pension obligations and operational budget;**Pension obligations; over $17 million.
2013	Detroit, Michigan	**Pension obligations and operational budget;** Largest municpal filing in U.S. history. Debt estimated 18-20 billion.

Table 5. Recent Pension Reforms

Year	State	Actions taken
2003	Oregon	Restructured to a hybrid plan with a DB and DC component;Capped COLA at 1.5% on all benefits above $20,000.
2005	Alaska	Created a defined contribution plan for new employees.
2008	Kentucky	2008: Extends the period of calculation for FAS; Reduces COLAs (House Bill 1); 2013: Created a hybrid plan for new employees
2009	Mississippi	Increased employee contribution rates; Changed eligibility requirements for new employees.
2009	Colorado	Changed COLA terms; Increased employee contributions; Modified formula used to calculate benefits 2011;
2009	New Hampshire	Increased contribution rates.
2009	New Mexico	Temporarily increased employee contributions; Created new tiers for state and educational employees;
2010	South Dakota	Removed COLAs for first year of retirement; Tied future COLA payments to system funded status.
2010	Delaware	Increased retirement age for new hires; Increased employee contributions.
2010	Pennsylvania	Created a shared risk DB plan for new employees, where employee contribution rates rise and fall based on investment returns; Changed the formula used to calculate benefits.
2010	West Virginia	Teachers' plan converted back to DB after 17 years of DC.
2010	Virginia	Employees required to contribute to pension (employer previously picked up); Change made to the calculation of average final salary; COLA match reduced.
2010	Vermont	Increased contributions for all TRS members ;Increased contributions for SRS members from 2011-2016.
2010	Missouri	Employee contributions raised; Retirement age raised.
2010	Minnesota	SRS: Reduced COLA;PERA: Increased contribution rates;TRS: Increased contribution rates incrementally.
2010	Wyoming	Requires employee contributions for the first time since 1991 ; Created a new tier for new employees with reduced benefits.
2010	Nevada	Allows for an increase in employee contributions; Reduced COLA for new employees; Modified the formula used to calculate benefits for new employees
2010	Utah	Closed the DB plan to new hires; created a Tier II retirement system for new employees, who choose between a DC plan and a hybrid plan (S.B. 63)
2010	Michigan	Created a hybrid plan for new school employees; Increased contribution rates for the two defined benefit tiers which were closed by the 2010.
2011	Arizona	Increased contribution rates; Modified the formula used to calculate benefits.
2011	New Jersey	Increased employee contributions; Modified formula used to calculate benefits.
2011	Kansas	Created a cash balance plan for state employees and teachers hired after.
2011	Rhode Island	Increased the normal retirement age; Temporarily suspended COLA.
2011	Wisconsin	Requires employees to pay half of the actuarially required contribution (employers have previously picked up employee contributions).
2011	Massachusetts	Future Employees: Increased retirement age and modified the formula used to calculate benefits; Current and Future Employees: Changed method used to calculate.
2011	Georgia	Created a hybrid plan for new employees.
2011	Maryland	Increases employee contributions.
2011	Florida	Increased employee contributions.
2011	Montana	Increased contribution rates for new employees; decreased cost-of-living adjustment for current retirees.
2011	Maine	Froze Cola for three years; Raised retirement age for all members with less than five years of service.
2011	North Dakota	Increased state employee contributions; Increased teacher contributions.
2012	South Carolina	Changed benefit calculations for new employees.
2012	California	Increased employee contributions; increased retirement age.
2012	Virginia	Created a hybrid plan; Reduced the pension multiplier; Modified the formula used to calculate pension benefits.
2012	New York	Created a new tier (Tier VI) for newly hired employees which features a higher normal retirement age, a lower pension multiplier, and higher employee contributions.
2013	New Mexico	PERA: Reduced COLA for retirees receiving $20,000 or less; changed COLA eligibility for new hires. Increased employee contributions for all workers; ERB: Reduced COLA for current retirees and increased contributions for current members.
2013	Louisiana	Created a cash balance plan for state employees and teachers hired after July 1, 2013 .
2013	Puerto Rico	Increased the retirement age; increased employee contributions; reduced benefits; created a hybrid plan.
2013	Oklahoma	Increased the retirement age and vesting period for new firefighters. Increased firefighter contribution rates.
2013	Nebraska	Created a new tier for newly hired school employees with a longer period used to calculate FAS and a reduced COLA.
2013	Tennessee	Closed the DB plan to new state and higher education employees and teachers hired after July 1, 2014. Created a new combination (DB/DC) hybrid plan for these employee groups.

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