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Has weak lending and activity in the United Kingdom been driven by credit supply shocks?

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Abstract

This paper investigates the role of credit demand and supply shocks in driving the weakness in UK banks' lending and economic activity during both the recent financial crisis and the various UK financial crises since 1966. It uses a structural vector autoregression analysis to identify separate credit demand and supply shocks in addition to the standard macroeconomic shocks that are typically analysed in this framework. It finds that credit supply shocks can account for most of the weakness in bank lending since the onset of the crisis and between a third and a half of the fall in GDP relative to its historic trend. It also finds that credit supply shocks appear to behave more like aggregate supply shocks than aggregate demand shocks because they cause output and inflation to move in opposite directions. This may be because credit supply shocks affect potential supply in the economy or because they have a significant exchange rate effect. The results appear robust to different identifying assumptions. The main sensitivity appears to be when spreads are treated as a non-stationary variable and long-run restrictions are placed on the model.

Key words: Credit supply shocks, financial and macro linkages, Bayesian SVARs, sign restrictions, long-run restrictions.

JEL classification: C11, C32, E51, E52.

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Summary

The recent financial crisis has focused attention on the importance of credit supply and other financial shocks on the real economy. Prior to the crisis macroeconomists were typically interested in explaining movements in macroeconomic variables in terms of only a small number of aggregate level shocks, such as those from aggregate supply, aggregate demand and monetary policy. As a result the specific role of credit and financial market shocks were implicitly subsumed within one or other of these aggregate macroeconomic shocks. This paper attempts to disentangle the impact of credit market shocks on lending and activity in the UK economy. In particular we address three related questions that have been prompted by the recent financial crisis:

(i) Are shocks to the supply of credit more like aggregate demand or supply shocks ?
There is a growing literature that suggests shocks to the credit market can have permanent effects on potential supply. In some models that can mean that inflation rises rather than falls in response to a contraction in credit supply and a fall in output. What does the UK evidence suggest ?

(ii) How does a credit market shock differ from a monetary policy shock ?
Both have an observationally equivalent effect on loan rates in the economy, but are they similar enough that monetary policy is able to offset a substantial part of a shock to credit supply. And how easily can we distinguish their separate effects in the data ? In particular, do credit supply shocks have an additional quantitative effect via rationing and other non-price terms in addition to an effect operating via loan rates?

(iii) What has been the role of credit supply shocks in the recent crisis ?
Have credit supply shocks rather than shocks that affect credit demand been the most important factor driving the slowdown of UK bank lending during the financial crisis ? And how much of the slowdown in UK activity can we attribute specifically to UK-specific credit shocks and how much to other factors such as global activity and uncertainty ?

To address these issues we estimate a structural vector autoregression (SVAR) model for the UK economy over a data set that goes back to the late 1960s. The SVAR approach involves estimating a set of variables where each variable is regressed on past movements of itself and the other variables in the system. The unexplained component of each variable is then decomposed into the impact of different fundamental or 'structural' shocks using a theoretically-based set of sign and timing restrictions for the shocks we wish to identify .

In this paper we identify six structural shocks using this SVAR analysis. We use standard sign restrictions on the pattern of reactions on specific variables to identify the three standard macroeconomic shocks mentioned above that are typically analysed in this framework – aggregate demand, aggregate supply and monetary policy. These shocks are commonly identified as aggregate demand if it moves inflation and GDP in the same direction, whereas an

aggregate supply shock moves them in the opposite directions. The sign of the interest rate impact is then used to distinguish between monetary policy shocks and other aggregate demand shocks. Namely, a monetary policy shock leads to output and interest rates moving in an opposite direction whereas other aggregate demand shocks would usually lead to an interest movement in the same direction as output (as monetary policy attempts to offset the impact). We then use an additional set of timing and sign restrictions to identify specific credit and financial market shocks. One of these is identified uniquely as a shock to the supply of credit by banks. The other two are identified as shocks to the corporate bond and equity markets that affect the demand for bank credit for a given level of activity in the economy. So overall we are able to identify a shock to credit supply and a number of shocks that will affect credit demand in the economy. The identified shocks look plausible when we use them to explain the past 50 years of UK economic history.

When we apply this analysis to the crisis we find that:

- **Credit supply shocks look more like aggregate supply than aggregate demand shocks.** Credit supply shocks that lower bank borrowing and output appear, if anything, to have a positive effect on inflation. Our analysis suggests that some of this may reflect an effect of credit supply shocks on the exchange rate as well as an effect on potential supply. This could reflect the importance of financial services in UK trade. That means that credit supply shocks are also significantly different to monetary policy shocks which push output and inflation in the same direction for a given impact on interest rates in the economy.

- **Credit supply shocks look to have an important quantitative dimension.** When compared to a monetary policy shock that has an equivalent effect on loan rates, the quantity of credit appears to move almost (three) times as much.

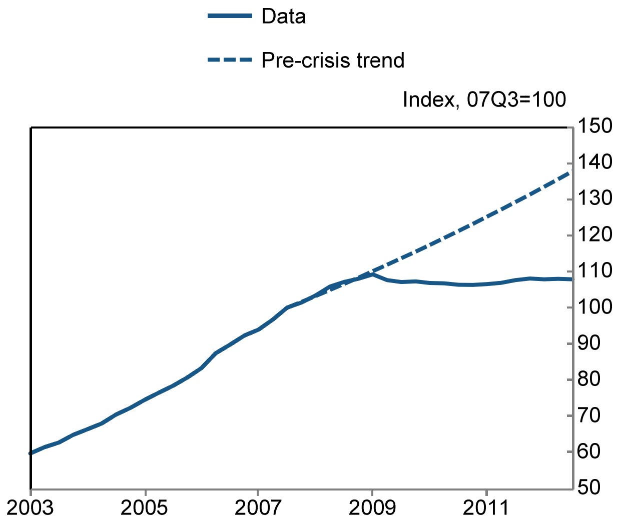
- **Credit supply shocks can account for most of the rise in credit spreads and most of the slowdown in bank lending over the crisis**. Shocks affecting credit demand only appear to be marginally important in 2010 and 2011.

- **Credit supply shocks can account for up to a half of the fall in UK GDP relative to its pre-crisis trend.** Other shocks to aggregate demand and supply appear to have also played an important role in driving weak demand. Monetary policy (both through interest rates and quantitative easing) appear to have had a significant role in offsetting these shocks.

Introduction

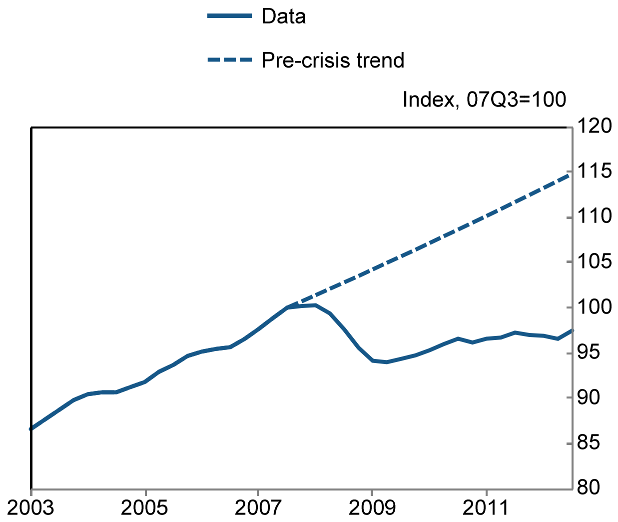
The recent financial crisis has focused attention on the importance of credit supply and other financial shocks on the real economy. Since the start of the crisis in 2007Q3 the stock of bank and building society lending has fallen by around 25% relative to its pre-crisis trend and the level of real GDP as fallen by over 15% on the same comparison (Charts 1 and 2).

Chart 1: Stock of nominal aggregate M4 lending relative to pre-crisis trend



Note: M4 lending excluding lending to intermediate OFCs and excluding the impact of securitisations

Chart 2: Real GDP relative to pre-crisis trend



Prior to the crisis macroeconomists were typically interested in explaining the movements in macroeconomic variables in terms of only a small number of aggregate level shocks, such as aggregate supply, aggregate demand and monetary policy shocks. As a result the specific role of credit and financial market shocks were subsumed within one or other of these aggregate macroeconomic shocks. This paper attempts to disentangle the impact of credit market shocks from these aggregate shocks and quantify their role in driving the behaviour of lending and activity throughout the crisis. Along the way we also examine two other questions:

- **Do shocks to the supply of credit look more like aggregate demand or supply shocks ?** There is a growing literature that suggests shocks to the credit market can have permanent effects on potential supply. In some models that can mean that inflation rises rather than falls in response to a contraction in credit supply and a fall in output. We look at what the UK literature suggests.

- **How does a credit market shock differ from a monetary policy shock ?** Both have an observationally equivalent effect on loan rates in the economy, but are they similar enough that monetary policy is able to offset a substantial part of a shock to credit supply ? Are there quantity rationing effects from credit supply shocks that are absent under monetary policy shocks ?

To address these issues we estimate a structural vector autoregression (SVAR) model for the UK economy. The SVAR approach involves estimating a set of variables where each variable is regressed on past movements of itself and the other variables in the system. The unexplained component of each variable is then decomposed into the impact of different fundamental or 'structural' shocks. To perform this decomposition each shock must be uniquely identifiable from the others using restrictions based on the sign and timing of each shock. So for example an aggregate demand shock would typically be identified as one that moves prices and output in the same direction whereas an aggregate supply shock would be assumed to move prices and quantities in an opposite direction. Provided we have enough unique sign and timing restrictions for the shocks we wish to identify we can decompose the movement of each variable into the effects of current and past outturns of shocks.

The rest of the paper is structured as follows. The first section reviews the growing literature on credit supply shocks and discusses how our paper fits in and contributes to it. The next section discusses the econometric model, the data we use and the identification of different types of shocks. Section 3 then uses an impulse response function analysis to examine the properties of a credit supply shock. Section 4 goes on to use a historical decomposition analysis to discuss the main drivers of lending and GDP growth both historically and during the recent financial crisis. Section 5 then carries out a robustness check on the identification procedure and looks at the sensitivity of our conclusions to different identifying assumptions. Section 6 concludes.

1 Recent literature on credit supply shocks

Due to the empirical difficulty in distinguishing between the importance of credit supply and demand shocks on the evolution of the business cycle, a large part of the literature discusses the effects of credit supply shocks using firm or bank level data. Peek et al (2003) is perhaps the most prominent study that uses micro data to specifically identify shifts in the supply of loans for the US economy. They find that changes in real business inventories exhibit the strongest reaction to changes in the bank health which impacts negatively on economic growth. More recently Gilchrist et al (2009) use a broad array of credit spreads constructed directly from the prices of secondary corporate bonds issued by a panel of nonfinancial companies. They find that shocks emanating from the corporate bond market (defined as movements in spreads that are orthogonal to the information contained in stock prices of the same set of firms and other macroeconomic factors) account for more than 30 percent of the forecast error variance in economic activity at the two- to four-year horizon and contributed significantly to U.S. economic fluctuations during the 1990-2008 period. For Japan, Woo (2003), using bank level data, and Bayoumi (2001), using macro aggregates, find that the banking sector contributed to the prolonged slowdown in Japanese GDP in the 1990s.

More recently DSGE models that contain a banking sector have become more prominent (see Gerali et al (2010), Gertler and Karadi (2011) for example). That has allowed empirical work that incorporates insights of this work to emerge. Peersman (2011) uses sign restrictions to discuss the effects of different types of lending for the euro area economy and finds that an increase in the risk taking appetite of banks triggered by shifts in long-term interest rates or in the term spread lead to a reduction of government loans' volume and an increase in the volume of loans to the private sector. Hristov et al (2012) using a larger econometrical model for the euro area finds the opposite, namely that credit supply shocks have a contractionary effect on GDP growth for the euro area countries. There are a few reasons why these two papers may reach different conclusions. While Peersman (2011) uses aggregated euro area data, Hristov et al (2012) estimate a panel VAR. Also Hristov et al (2012) identify a different mix of shocks to Peersman (2011), the only one overlapping being the credit supply shock. More recently Gambetti and Musso (2012), using an SVAR analysis similar to our own, support the results of Hristov et al (2011) and find that credit supply shocks are important for both lending and growth in the euro area, US and UK. There has also been work on the role of credit supply shocks at a global level. De Nicolo and Lucchetta (2010) and Helbling et al (2010) look at the role of credit market shocks in the G7. While Eickmeier and Ng (2011) identify US, European and Japanese credit supply shocks and discuss how these propagate to another 33 countries.

We contribute to this growing empirical literature by estimating an SVAR model for the UK economy and distinguishing between the various shocks that drive the demand for credit and those that drive the supply of credit. Our paper is different to most of the literature because we try and identify a broader set of shocks. Eickmeier and Ng (2011), for example, focus only on credit supply shocks. While Gambetti and Musso (2012) focus on identifying just three shocks – aggregate demand, aggregate supply and loan supply. That leaves the role of monetary policy (and other financial market) shocks ambiguous as in principle they will be mixed up in the aggregate demand and loan supply shocks. We attempt to identify a larger number of shocks – six in total – that we group into three aggregate shocks (aggregate demand, aggregate supply and monetary policy) and three financial market shocks, a credit supply shock and shocks to the corporate bond and equity markets that might lead to substitution away/towards bank credit. This allows us to compare credit supply shocks with both aggregate supply and monetary policy shocks. And it allows us to look at the role of capital market substitution as separate influence on the demand for credit. Also, by attempting to identify as many shocks as there are variables in our system, it can help to uncover the underlying impulse response function for the credit supply shock itself (Paustian 2007). One other important feature of our paper is that we use a data set going back to the 1960s so we can take a historical perspective on credit supply shocks in the UK and discuss how past developments either regulatory or market induced have manifested themselves in credit supply shocks.

2 Empirical model

To recover the different shocks that shift the supply and demand for credit and to analyse their impact on other variables we employ a structural vector autoregression or SVAR analysis to a small system of variables. A general unrestricted VAR model involves regressing each endogenous variable in the system on lagged levels of itself and all the other endogenous variables. This can be written :

$$B(L)X_t = d + \xi_t \qquad (1)$$

Where: X_t are the endogenous variables in the VAR; d is a set of deterministic terms such as constants and shift dummies; and the ξ_t are the N(0, I) distributed unrestricted error terms or reduced-form residuals of the VAR which, without further restrictions, have no underlying economic interpretation. $B(L)$ is a lagged polynomial given by = $I + B_1L + B_2L^2 .... B_NL^N$, where N is the lag length of the VAR and needs to be determined.

The underlying structural economic shocks η_t are defined as a linear combination of the reduced- form errors, $\eta_t = A_0^{-1} \xi_\tau$. So each reduced-form residual can be written as $\xi_t = A_0 \eta_\tau$ where A_0 is the impact matrix of each structural shock. In order to recover the structural shocks we need to indentify each shock uniquely by applying a set of restrictions to the matrix A_0. Below we discuss the VAR specification and the identifying restrictions in more detail.

2.1 Data choices

Our aim is to look at the role of credit supply and demand shocks during the various financial crises to have hit the UK in the post-war period. In practical terms this means using a sample period from the mid-1960s onwards when quarterly financial data become readily available. To disentangle the role of credit supply and credit demand shocks we have estimated a system that includes standard macroeconomic variables – inflation, real GDP growth and a monetary policy instrument. But we also include a number of credit and financial market variables to help identify credit supply and demand shocks separately from the standard macroeconomic shocks. The data we use are as follows:

- For inflation we use a seasonally-adjusted measure of quarterly CPI inflation extended back to the 1960s using the ONS's long-run measure of consumer prices (see O'Donaghue, Goulding and Allen (2004))

- For quarterly real GDP growth we use the headline measure of real GDP at market prices.

- For the policy rate we use a zero-coupon 10 year bond yield rather than Bank Rate. In part this is because, since 2009, the Bank of England's Monetary Policy Committee (MPC) have been using asset purchases or Quantitative easing (QE) as its main policy instrument given

Bank Rate is close to the floor imposed by the zero bound. The assets purchased by the MPC are, for the most part, government bonds and the key channel is via their impact on the yields of those securities. So movements in gilt yields should reflect both instruments of monetary policy provided changes in Bank Rate also typically affect rates further out along the yield curve. A simple error-correction model (see Appendix 2) suggests long-run gilt yields move on average by around a third of the change in Bank Rate with a high level of significance. Identifying the shocks via restrictions on long rates should avoid any distortions arising from the zero bound that might affect interpretation of shock decompositions over the crisis period. A second reason for choosing the 10 year bond yields is that it is also the reference rate for our credit spread measure (discussed next). This allows us to produce responses for both credit spreads and overall yields (spreads + reference rates) which helps assess the plausibility of the responses.

- For our central case measure of credit spreads we use investment-grade UK corporate bond spreads covering all companies, including financial companies. Our use of corporate bond spreads reflects the fact that we have a relatively continuous series we can take back to the 1960s. The spreads we used are option-adjusted measures from Bank of America which go back to 1997. Prior to this we use yields from Global Financial Data back to 1966. Corporate bond spreads have been found to be a useful summary measure of credit conditions in US studies (eg Gilchrist et al (2009) and Gilchrist and Zakrajsek (2012)). And the inclusion of financial company spreads means that we should pick up movements in bank funding costs which would feed into the borrowing rates faced by households. A preferable alternative would be to have used actual bank borrowing rates faced by companies and households. But these are less readily available before the mid-1990s.

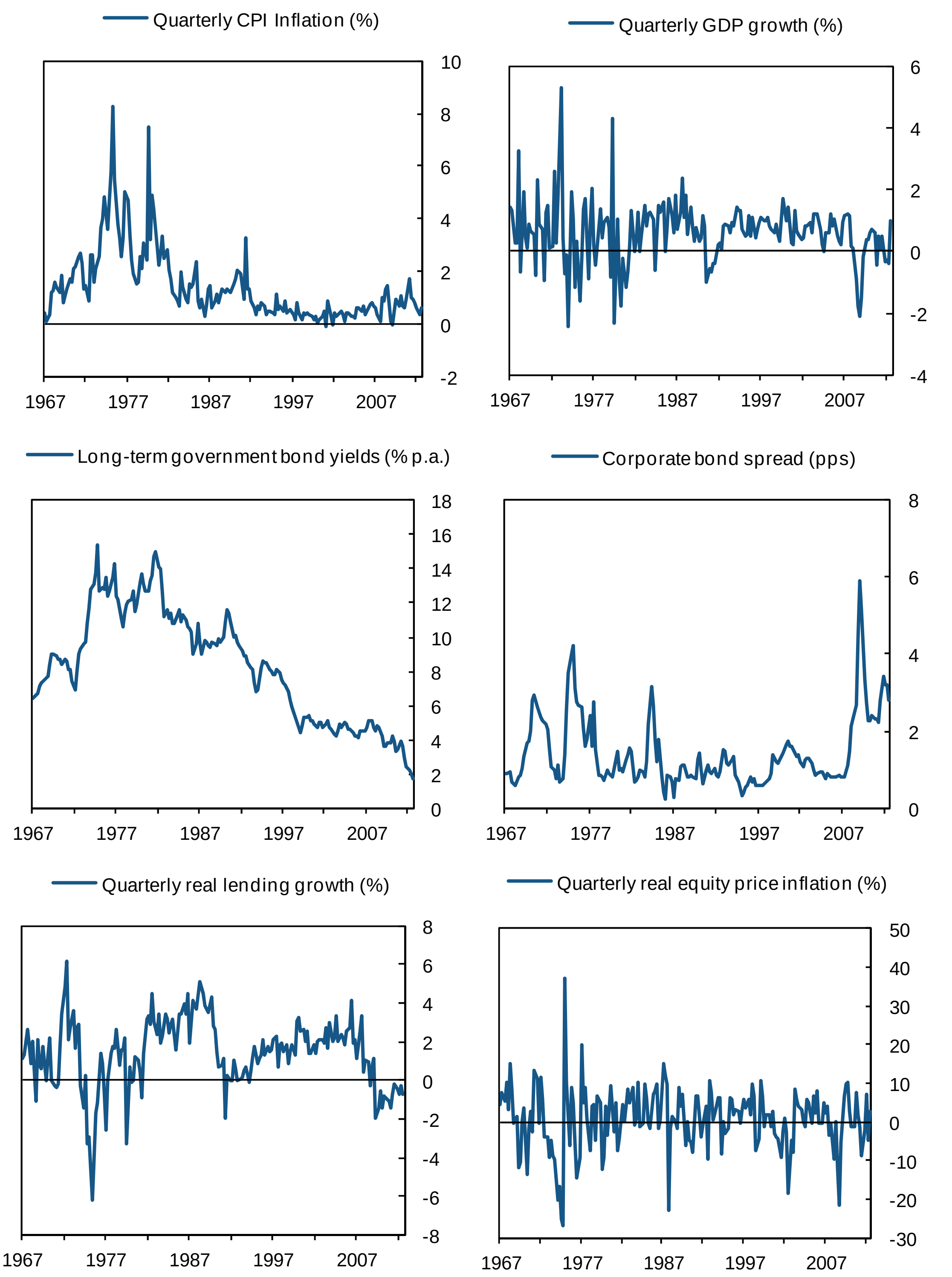
- For the growth of credit quantities we use the quarterly growth rate of the real break-adjusted[1] stock of M4 lending (essentially bank and building society lending) to households, PNFCs and non-intermediate OFCs. This measure is also adjusted for the impact of securitisations, so any securitised-loans are retained within the stock. This 'headline' measure of M4 lending is often referred to as M4Lx(ex). The CPI extended back to 1966 is used to deflate the series.

- For the growth in real equity prices we use the quarterly percentage change in the FTSE All-Share index deflated by our extended CPI series.

The data series are charted in Chart 3.

[1] The break-adjustment method corrects for any breaks in the stock series arising from changes in the reporting population, classification changes, revaluation effects and write offs. The break-adjusted stock takes the latest estimate of the unadjusted stock of lending and projects this backwards using transactions data on the flow of lending. See http://www.bankofengland.co.uk/statistics/Pages/iadb/notesiadb/Changes_flows_growth_rates.aspx for more details.

Chart 3: Data series used in the SVAR



2.2 Stationarity of the data and cointegration

The transformations of the data we have chosen are intended to delivery stationary series so that the VAR can be estimated straightforwardly via OLS. But unit-root tests on the data (Table 1) suggest there are two issues with our transformations and which are visible in Chart 3.

Table 1: ADF stationary tests

Series	t-Stat	Prob.	Obs
Inflation	-2.302	0.1726	182
GDP growth	-5.191***	0.0000	182
Long-term bond yields	-0.519	0.8835	182
Credit spreads	-3.810***	0.0034	182
Real lending growth	-3.185**	0.0225	182
Real equity price growth	- 5.957***	0.0000	182

Notes: A '***' represents rejection of the null hypothesis (that the series has a unit root) at the 1% level, a '**' a rejection at the 5% level and a '*' rejection at the 10% level.

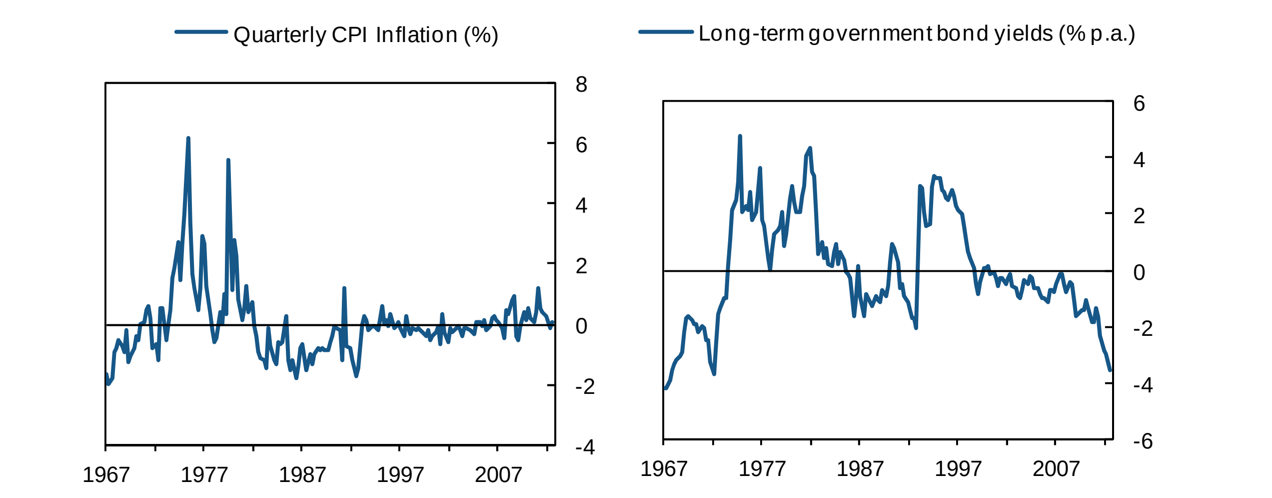
First both inflation and long-term interest rates appear to undergo a mean shift following the introduction of inflation targeting in the early 1990s. If we regress both series on a dummy starting in 1993Q1 and carry out an ADF test on the residuals we find we can reject the null of a unit root in the inflation series at the 1% level. And we can reject a unit root in the long-term bond yield but only at the 10% level (see Table 1a and Chart 3a). In our central case we treat the long-term bond yield as stationary after accounting for the mean shift but we carry out a robustness test of this assumption in the final section of the paper where long-term rates are assumed to be non-stationary. To account for the mean shift in the VAR we introduce a shift dummy into the system that takes a value of 1 prior to 1993Q1 and zero thereafter.

Second, the credit spread variable although it passes a stationarity test over the whole sample shows some signs of a break or mean shift at the start of the crisis. This raises an important issue about whether credit supply shocks ultimately have a permanent effect on credit spreads. If credit spreads enter the VAR in levels but the stock of lending enters as a growth rate then a credit supply shock will permanently affect the stock of lending but will only temporarily (albeit persistently) affect the level of credit spreads. If however spreads are entered in differences (so that the level of credit spreads is assumed to follow a stochastic trend) then credit supply shocks will be allowed to have a permanent effect on both spreads and the stock of borrowing. This, as we show later, matters quite a lot when interpreting the role of credit supply shocks over the recent past. In our central case we treat credit spreads as a stationary series but again we show the implications of this assumption in our sensitivity analysis in section 6.

Table 1a: ADF stationary tests after regressing on post 1993Q1 dummy

Series	t-Stat	Prob.	Obs
Inflation	- 4.115***	0.0012	182
Long-term bond yields	- 2.608*	0.0932	182

Chart 3a: Data series used in the SVAR after accounting for mean shift



Finally we also need to check whether there is cointegration among the variables that have been transformed from levels to growth rates. If there is cointegration in the levels of these variables that would suggest there are stationary long-run relationships that we need to take account of when estimating the VAR. In other words we would need to estimate a vector error/equilibrium correction mechanism or VECM that would include these long-run relationships as right-hand side variables in the VAR, rather than estimate a straightforward VAR in growth rates. It would also suggest there were fewer permanent shocks than variables driving the underlying stochastic trends in the data. We test for this by estimating the VAR in levels and applying the method of Johansen (1992) to determine the potential presence of cointegration in the system. Given the potential deterministic mean shift in the inflation rate and the difficulties of identifying its order of integration we test for the presence of cointegration in just a three-variable system of real GDP, real lending and real equity prices. The results are shown in Appendix 3. The tests suggest there is little evidence of cointegration in the three-variable system. So we proceed on this basis.

2.3 Reduced-form VAR specification and lag length

To determine the lag length of the VAR we used the Akaike and Schwarz information criteria to guide us. Those suggested a short lag length of 1 or 2, so we adopted 2 for our specification. So our unrestricted VAR model is given by.

$$X_t = \beta_0 + d^{IT} + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \xi_t \quad (2)$$

β, $i = \{1,2,3\}$ are the reduced-form coefficients (including the constant) and d^{IT} is the dummy variable that takes the value of 1 before the introduction of inflation targeting in 1992Q4 and 0 thereafter. The dummy variable is constrained to only affect the inflation and interest equation and none of the rest. The X_t vector comprises all our variables, namely quarterly inflation, real GDP growth, long-term bond yields, credit spreads, real lending growth and real equity price inflation. Given a lag length of 2 the effective sample period is from 1966Q3 to 2012Q3.

2.4 Identification of structural shocks

We attempt to decompose these six variables into the contributions from six structural shocks. The first three represent the standard aggregate shocks that are typically analysed in macroeconomics. The remaining 3 shocks represent credit and financial market shocks. As noted earlier we need to apply a set of restrictions to recover the structural shocks. We use a set of timing and sign restrictions to identify each shock, which we discuss in turn:

Aggregate shocks

We identify the three aggregate shocks using sign restrictions. As noted earlier an aggregate demand shock is identified as a shock that moves inflation and GDP in the same direction, whereas an aggregate supply shock moves them in an opposite direction. The sign of the interest rate impact is then used to distinguish between monetary policy shocks and other aggregate demand shocks. So a monetary policy shock leads to output and interest rates moving in an opposite direction whereas other aggregate demand shocks would usually lead to an interest movement in the same direction as output (as monetary policy attempts to offset the impact). Each of these aggregate shocks can be thought of as shocks that would typically shift the demand for credit by affecting the level of activity and the general level of interest rates.

Credit and financial market shocks

We also identify three credit and financial market shocks which are distinguished from the three aggregate shocks by a timing restriction. Such shocks are assumed not to have an immediate impact on aggregate macroeconomic variables as they originate in the financial sector and take time to filter through to product markets.

Within this group our focus is on identifying a credit supply shock . We identify it on the basis that it would typically lead to an opposite movement between credit spreads and lending (so rising spreads at the same time as a reduction in lending). One might think of the credit supply shock as reflecting one of the following: a worsening of bank's assets (as in Gertler and Karadi (2011)), a decline in bank capital (Gerali et al (2010)), an increase in expected or realised default risk (Christiano et al (2010), Atta-Mensah and Dib (2008)) or simply heightened risk aversion by investors unrelated to credit default (Gilchrist et al. (2009), Peersman (2011)). But whichever it reflects, it must do so over and above the usual cyclical response of these factors to the standard macroeconomic shocks we have already identified. So for example a positive aggregate demand or supply shock might be expected to reduce default risk and credit spreads.

Apart from the 0 restrictions we do not impose any other restrictions on the response of output, inflation and the Bank Rate to a credit supply shocks. Some theoretical models suggest that the response of inflation and the interest rate should be positive following such a shock (Gerali et al (2010) and Atta-Mensah and Dib (2008)) while others suggest that these should be negative (Curdia and Woodford (2010), Gertler and Karadi (2011)). We leave this to be freely-determined in our framework.

In addition to the credit supply shock, we also attempt to identify a capital market substitution shock that would move corporate bond yields in the same direction as M4 lending. We think of this as a preference shock to the demand for credit *at a given level of activity* that results from a substitution between capital market finance and bank lending. If corporate bond yields increase that should induce corporates to switch towards bank borrowing at a given level of activity.

Finally, to explain the volatility in equity prices compared to other variables in the system, we identify an equity price shock which we assume has no contemporaneous impact on any of the other variables. Our prior is that this shock will largely reflect noise in the equity price that has little impact on other variables in the system (which is borne out in our initial results) but equally we could classify this as a shock that would shift the demand for credit in a similar way to the capital market substitution shock.

So overall we identify 5 shocks that chiefly affect the demand for credit. Three of these are aggregate shocks that mainly affect the demand for credit via the overall level of activity and general level of interest rates. And two of these reflect shifts in the cost of bond and equity finance that mainly affect the demand for credit via a substitution effects at given levels of activity and risk-free rates. And we identify one shock that reflects shifts in the supply of credit. The restrictions are summarised in Table 2.

To impose the combination of zero and sign restrictions necessary to distinguish between the shocks we use standard, well-established techniques. In particular for the sign restrictions block we use the procedure introduced by Rubio-Ramirez, Waggoner and Zha (2005). Namely, let the $\Omega = PDP'$ be the eigenvalue-eigenvector decomposition for our VAR's covariance matrix Ω. The impact matrix of the structural shocks would then be $A_0 = PD^{1/2}$. To compute candidate impact matrices we draw a NxN matrix K from a $N(0,1)$ and then use the QR decomposition so that $K = QR$ [2]. This helps us get a new $A_0^{new} = A_0 * Q'$. If this satisfies the sign restrictions discussed above and also displayed in Table 1 we keep it. Otherwise we move on to the next Gibbs Sampler iteration. We use these saved impact matrices together with the coefficient estimates to compute the impulse responses as well as the historical decomposition.

[2] Please note that we apply the QR decomposition only for a part of the variance covariance matrix, namely the one for which sign restrictions apply.

Table 2: Summary of identifying restrictions

Shock/Variable	CPI inflation	GDP growth	Policy rate	Corporate Bond Spread	M4Lx growth	Equity prices
Aggregate supply	+	-	?	?	?	?
Aggregate demand	+	+	+	?	?	?
Monetary Policy	+	+	-	?	?	?
Credit supply	0	0	0	+	-	?
Credit demand	0	0	0	+	+	?
Equity price	0	0	0	0	0	1

Many of the restrictions we have used could be challenged on various grounds, especially the arbitrary timing assumptions required to identify the credit and financial market shocks. We check the sensitivity of these baseline assumptions to different identifying restrictions in section 6. In the next section we discuss the properties of our baseline restrictions.

3 Impulse response analysis – What does a credit supply shock look like ?

In this section we carry out an impulse response analysis of the estimated structural VAR. In particular we focus on the credit supply shock and how it compares to other shocks.

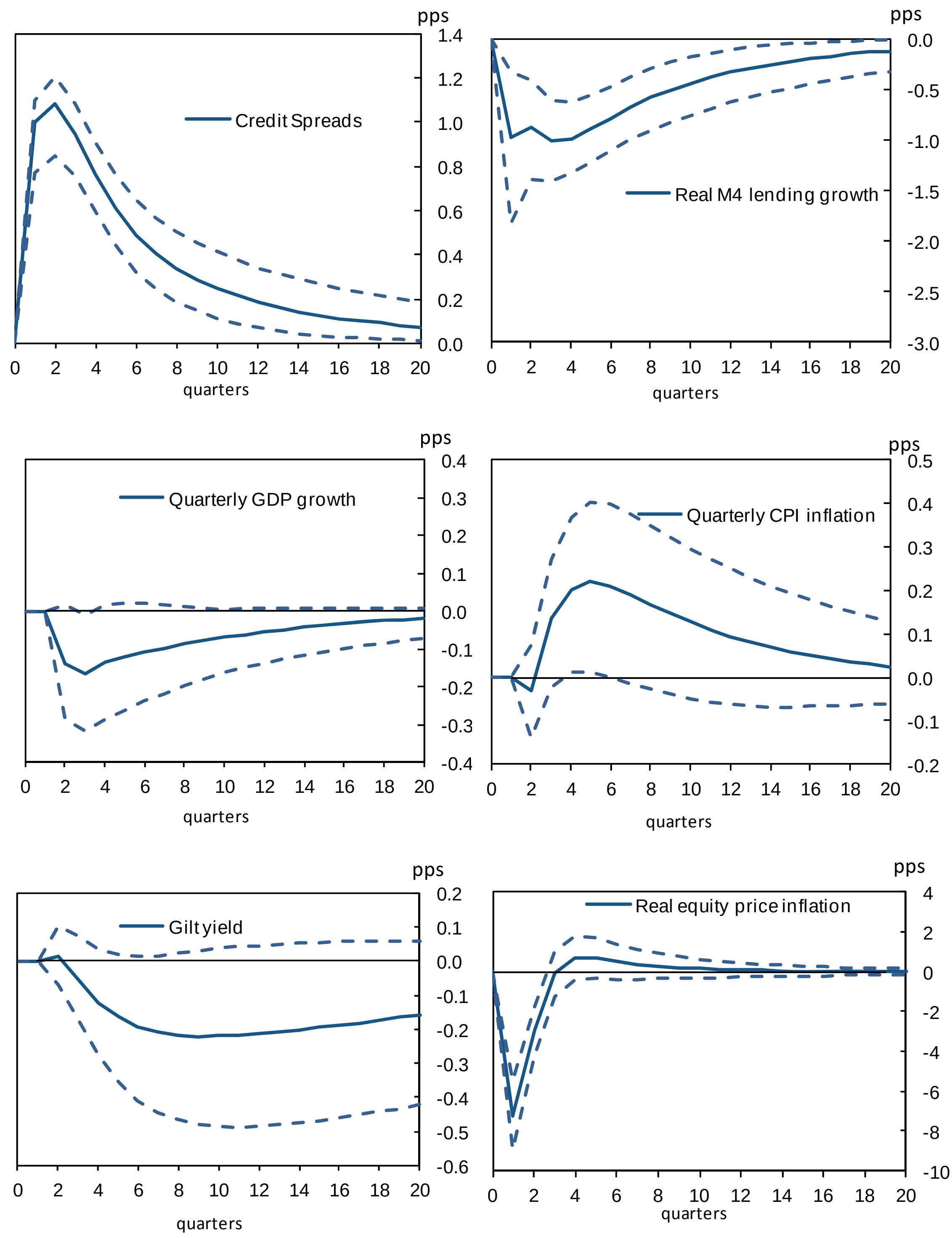
3.1 Does a credit supply shock look more like an aggregate demand or supply shock ?

Chart 4 shows the median impulse response of each variable in the VAR to a credit supply shock normalised to have a 1pp impact on credit spreads in the first period of the shock. One unit standard error bands are shown around each response.

Credit supply shocks have a significant positive effect on spreads and a significant negative hit on lending growth. When cumulated a credit supply shock that initially increases spreads by 1pp leads to around a 10% fall in the real stock of loans after about 5 years.

A credit supply shock that raises spreads and lowers borrowing has a negative effect on GDP growth – the response is marginally significant. This negative impact on activity occurs despite a loosening of monetary policy (strictly a fall in 10-year bond yields) that typically would occur in response to this shock. When cumulated, a credit supply shock that initially increases spreads by 1pp leads to a 1.4% fall in the level output when there is a monetary policy response. This rises to around a 3% fall if we switch off the monetary policy response. We can calculate this impact by simultaneously introducing a set of monetary policy shocks to keep the long rate constant.

Chart 4: Credit supply shock impulse responses



Despite a fall in GDP the inflation response is largely insignificant and is more likely than not to be positive. The peak response on annual CPI inflation could be as much as 0.8pp. That suggests that credit supply shocks might have a significant effect on potential supply so that the output gap moves little despite the fall in output under this shock (or even moves in the opposite direction). Additionally it might also suggest there is a cost channel effect (as in Barth and Ramey (2002)) where higher borrowing costs feed through into the price level because borrowing is an input into production. Overall it would suggest that credit supply shocks are more like aggregate supply than demand shocks.

An alternative interpretation is that a credit supply shock may induce movements in the exchange rate that cause a temporary impact on CPI inflation through higher import prices. The UK is an exporter of financial services and a credit supply shock is likely to induce a reduction in the supply of these services. To keep the trade balance at a sustainable level requires an exchange rate deprecation to induce a general increase in non-financial exports to fill the gap left by financial sector exports. To test this indirectly we run an auxiliary AR model for the exchange rate where we regress the change in the effective exchange rate on 2 lags of itself and the time series for each of the identified structural shocks[3]. This AR model indeed suggests that a contraction in credit supply that leads to a 1pp increase in credit spreads may depreciate the exchange rate by around 2.5%. Given a share of imports in final consumption of around a 1/3 that might, other things equal, imply a 0.8% direct impact on the price level were this to be fully passed on to import prices. So interpreting part of the positive inflation response in Chart 1 as the result of an exchange rate depreciation does not look implausible on this metric.

Real equity prices fall in response to a credit supply shock suggesting the effects on activity and risk premia outweigh the boost from lower real risk-free rates which unambiguously fall under this inflation response.

3.2 How does a credit supply shock compare with a monetary policy shock ?

We can also attempt to compare a credit supply shock with a monetary policy shock. The issue here is how to make them quantitatively comparable. One simple way to do this is to look at responses to credit supply and monetary policy shocks that are both scaled to deliver an initial impact of 100bps on the corporate bond *yield*. In the case of the monetary policy shock this movement in corporate bond yields is largely driven by the government bond yield. In the credit supply shock case we would want the 100bp movement in corporate bond yields to be driven by corporate bond spreads for a given government bond yield. To implement this we use the impulse responses for the credit supply shock with the average monetary policy response switched off as discussed earlier. Chart 5 shows that when we do this the path for corporate bond yields under both shocks is more or less identical over 20 quarters. So this would seem a sensible maturity matched comparison between a change in monetary policy and a credit supply shock, especially given that the current tool of monetary policy is quantitative easing which works through affecting longer-term yields. Joyce et al (2011) show that £200bn of asset purchases would initially be required to deliver a fall of 1pp in 10-year government yields.

But often when analysing monetary policy shocks researchers prefer to scale things in terms of a change in the short-term policy rate. The expectations theory of the term structure would suggest short-term rates will have to move a lot more in percentage points to deliver a given

[3] Ideally we would want to include exchange rates as an additional variable in the SVAR but this would require identifying an additional shock (such as an external demand shock or risk premium shock) which would require even more sign and/or zero restrictions. We leave this as a possible avenue for future work.

change in the long rate, if the change in rates is not expected to be permanent. Using the simple regression of long rates on short rates over the sample period (shown earlier), suggests that short rates typically need to move by 300bps or 3pps in the short run to deliver 100bps or 1pp on 10-year yields (shown in the first panel of Chart 5). So as an additional metric we scale the monetary policy responses to deliver 1pp on Bank Rate rather than the 10-year yield.

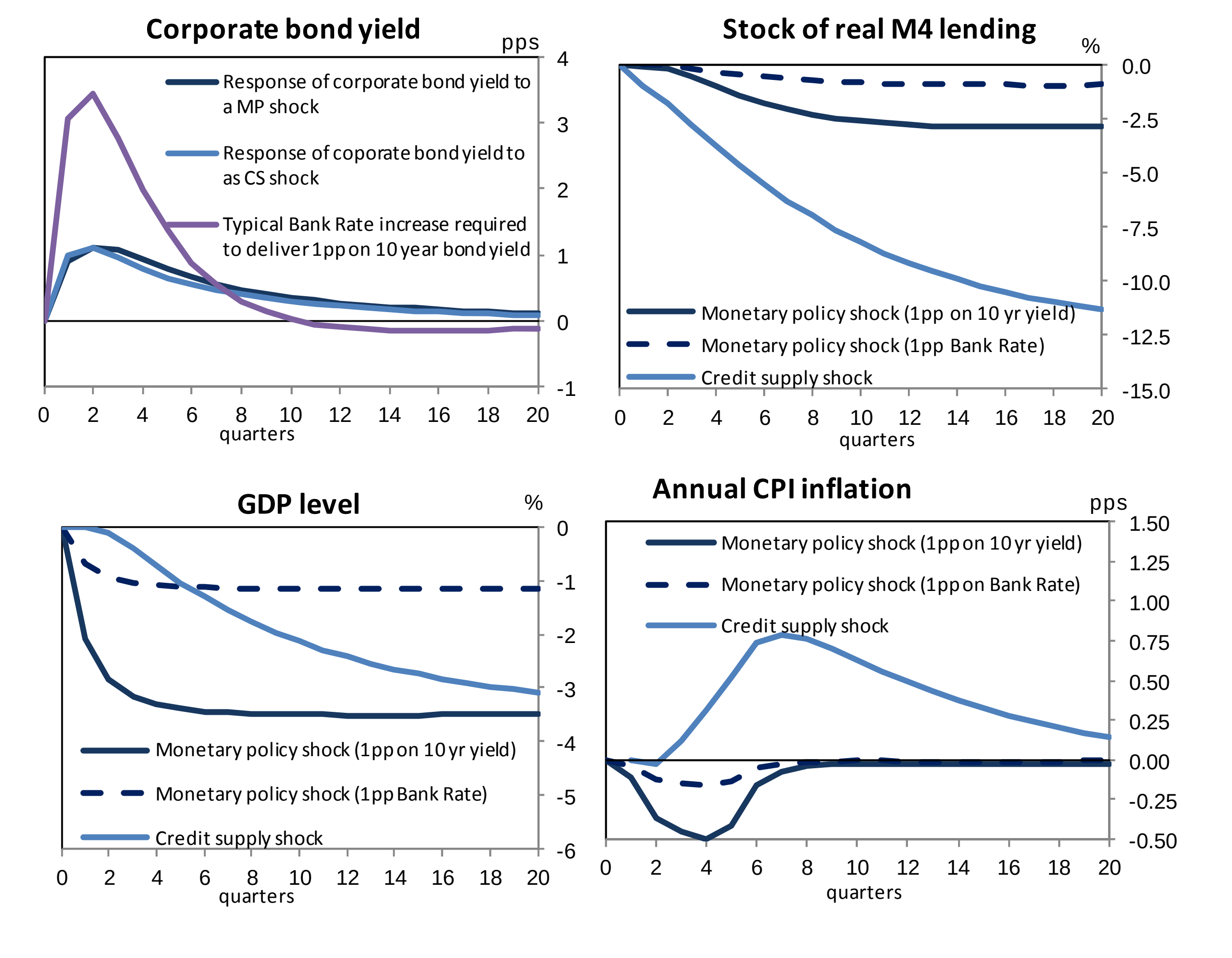
The second, third and fourth panels of Chart 5 compare the impact of credit supply and monetary policy shocks on the *stock* of real M4 lending, the *level* of GDP and the impact on *annual* CPI inflation. These transformations of the data allow a more revealing comparison between the shocks. Several interesting points emerge.

First credit supply shocks appear to have much larger impact on lending than an equivalent change in monetary policy, under both the maturity-matched and Bank Rate-scaled comparisons. That might suggest that under a credit supply shock there are substantial quantitative restrictions or rationing of credit that occurs over and above the impact of higher yields on the demand for credit (price channel) that would occur under both shocks.

Both monetary policy shocks and credit supply shocks have a permanent negative effect on the level of GDP. The sign and zero restrictions we impose on the SVAR do not impose any long-run restrictions. So in our central case specification we do not impose long-run monetary neutrality on the monetary policy shock. As noted earlier it is plausible that credit supply shocks have long-run effects on potential supply. We explore the implications of imposing monetary policy neutrality in our robustness analysis in section 6. For now we focus on a comparison of the short-medium responses and abstract from the long-term effects on GDP until later.

On both the maturity-matched and Bank Rate comparison a change in monetary policy has a bigger effect than a credit supply shock in the very short term. That probably reflects the direct cashflow effects on mortgages linked to Bank Rate (a credit supply shock should only affect the rates on new borrowing so would take some time to affect actual cashflows). It would also support the idea that the exchange rate depreciates under a credit supply shock whereas it should move in an opposite direction to a monetary policy tightening. Equity prices move similarly in the maturity-matched comparison.

Chart 5: Credit supply shock compared to a monetary policy shock



Over the medium term the effects of monetary policy and credit supply shocks are more comparable. A monetary policy shock that leads to a 100bp increase in long-term yields lowers the level of GDP by around 3.5% after three years. The equivalent credit supply shock impact on GDP builds up more slowly over time and after 3 years there is around a 2.5% impact on the level of GDP for a 100bp initial impact on spreads. The monetary policy shock impact is almost double the central case impact from Bank of England studies on the effects of QE (see Joyce, Tong and Woods (2011)) but is within the range of estimates of one of the studies used to make up that central case (see Kapetanios et al (2012)). Our monetary policy shock also reflects the average impact of Bank Rate and QE over the sample period rather than QE alone and so might be expected to be a bit larger than those QE impacts when scaled up, given that Bank Rate changes have direct cashflow effects on household income and are likely to have an exchange rate impact that are not factored into the Bank's QE estimates. When the shock is scaled to deliver a 100bp on Bank Rate the effect on GDP after two years is only around 1%. So a credit shock that leads to a 100bp impact on longer-term corporate bond spreads has two to three times the impact of an equivalent increase on Bank Rate. Overall our monetary policy shock estimates should be thought of as upper bound estimates. Canova and de Nicolo (2002) show that sign restricted SVARs often produce large contemporaneous responses to monetary policy shocks.

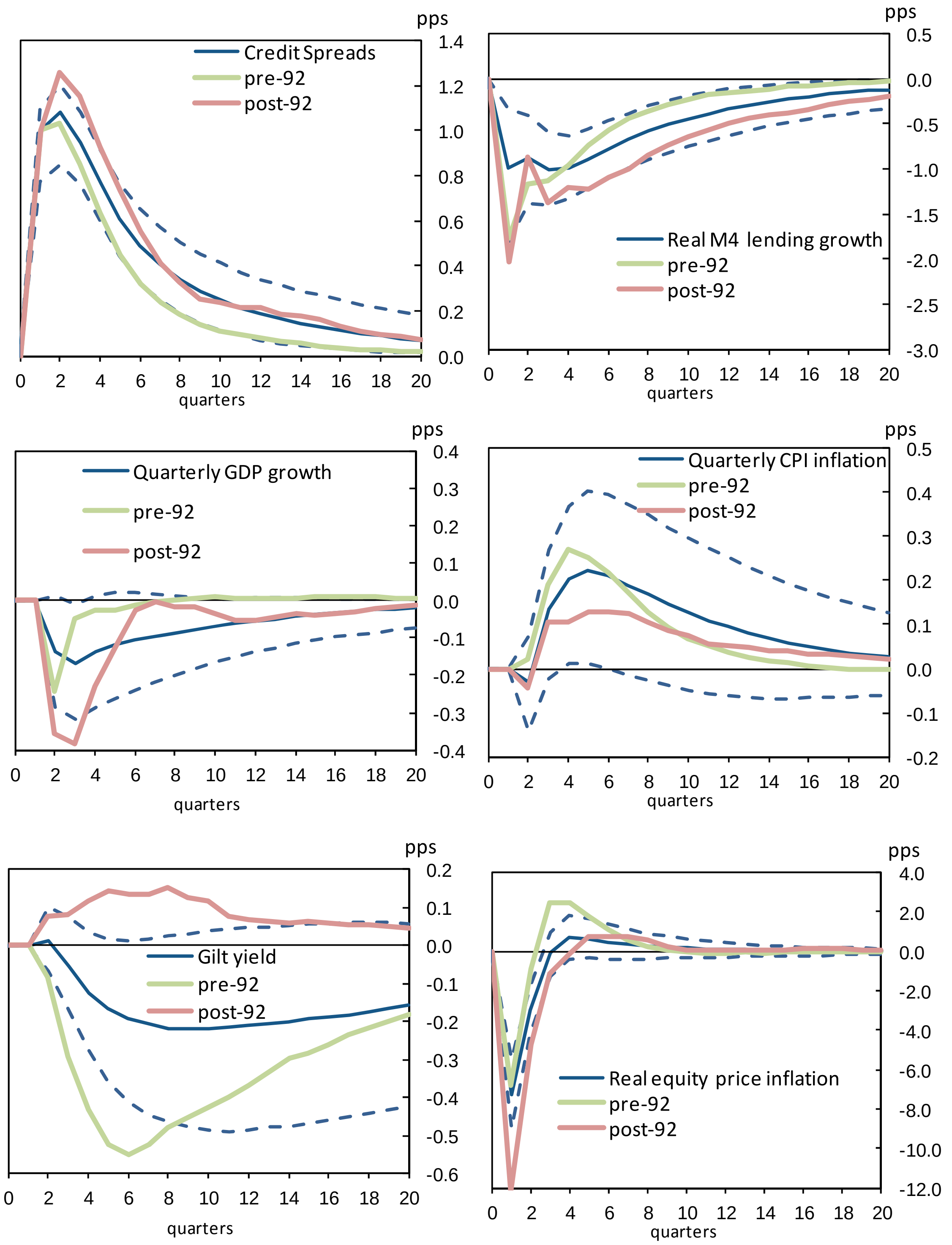
By construction (ie via imposing sign restrictions), monetary policy shocks have a negative rather than positive impact on inflation. As discussed earlier, it is suggestive that either the output gap and/or the exchange rate impact of a credit supply shock are respectively less negative and less positive than a monetary policy shock.

3.3 Is there evidence that the impact of a credit supply shock has changed over time ?

We estimated the SVAR over a long sample because the UK has experienced financial crises in the past and these might provide useful quantitative information about the impact of credit supply shocks. A counter to this argument would be that the structure of the economy has changed sufficiently over time that the impact of credit supply shocks may have been different in the recent crisis to those experienced in earlier historical episodes. To test this we look at two sub-samples of the data based around the 1993 break we discussed earlier. The post-1993 period reflects the shift in regime to inflation targeting and, prior to the financial crisis, is known as the Great Moderation period. In addition it represents a period when the financial liberalisation of the 1980s had largely run its course and was fully embedded in the UK financial system. So it seems a natural break point. Chart 5a shows impulse responses for each sub-sample compared with the whole sample responses and standard error bands in Chart 4.

The Chart shows that the responses look qualitatively similar to those over the whole sample. Credit supply shocks still push up on inflation and down on GDP unlike demand and monetary policy shocks. Quantitatively the responses in each sub-sample lie largely within the standard error bands of the whole sample, so they do not appear to be significantly different. If anything the post-1993 responses suggest credit supply shocks have a more persistent effect on spreads and a larger initial impact on GDP and lending, but a slightly smaller positive impact on inflation. The main difference appears to be the policy response, so it suggests we should treat this as highly uncertain.

Chart 5a: Credit supply shock impulse responses using different sub-samples



4 Historical Decomposition – How much did credit supply shocks contribute to the recession ?

In this section we use historical decomposition analysis to analyse the importance of credit supply shocks over the last 50 years and specifically during the recent crisis. This involves running a sequence of dynamic forecasts starting at a particular point in time. The first forecast is a base projection that takes the value of each variable at the start of the decomposition (reflecting the impact of shocks that have occurred before the start point) and maps out how each variable would return to its trend path in the absence of further shocks. The base projection will also reflect the impact of the shift dummy introduced in 1993. Given this base projection, the path of each structural shock is then sequentially fed into the SVAR until the resulting forecast is equivalent to the observed data. The marginal impact of each shock is then recorded to produce the historical decomposition.

4.1 What has driven credit spreads, lending and GDP over the past 50 years ?

Charts 6 to 10 show historical decompositions of credit spreads, lending growth (real and nominal), GDP growth and inflation over the whole sample, starting in 1967Q1, with the contribution of credit supply shocks highlighted in red. In each decomposition we highlight several key dates corresponding to particular periods of financial crisis in the UK as well as some of the well-known upswings and downswings of the post-war UK business cycle. We also show two decompositions of GDP. Chart 6 shows the standard decomposition with the average monetary policy response to each shock included in each shock's contribution. The second decomposition in Chart 7 shows the contribution of each of the non-policy shocks with long-term interest held fixed, to give an idea of what each shock might be contributing in the absence of a policy response. As in Section 4.2 we apply an additional set of monetary policy shocks to the SVAR sufficient to keep long-term rates fixed when calculating the contribution for each of the non-policy shocks. The monetary policy contributions in Chart 8 are then backed out by residual and can then be thought of as the contributions of changes in the long rate itself if these were implemented as a set of policy shocks. As noted earlier these contributions from long-term bond yields are likely to be an upper bound estimate of the impact of monetary policy.

The historical contributions suggest that the credit supply shocks we identify look plausible when seen in the context of the past 50 years of UK economic history. Credit supply shocks appear to be the dominant driver of movements in credit spreads. Contractionary credit supply shocks were the key drivers behind the rise in spreads in the midst of the secondary banking crisis in the mid-1970s, in the period following some US and UK bank failures in the mid-1980s, and especially in the post-2007 financial crisis. Positive shocks were also important in pushing down spreads in the first wave of financial liberalisation in the early 1980s and in the 2003-2007 credit boom.

The important role of credit supply shocks is mirrored in the decompositions of real and nominal lending growth shown in Chart 5, although the standard macroeconomic shocks and the capital market substitution shocks have also played a significant role. Credit supply shocks can explain most of the fluctuations in credit growth relative to trend both in the 2003-2007 boom and in the subsequent financial crisis. And credit supply shocks have also been important historically, driving the weak credit growth in the mid-1970s (reflecting both the secondary banking crisis and the operation of direct controls on credit such as the Supplementary Special Deposits scheme or "Corset"). They also contributed to the swings in credit growth in the early to mid-1980s, reflecting the impact of financial liberalisation from 1979 onwards and the bank failures of the mid-1980s. So, overall, this suggests our identified credit supply shocks are not implausible.

Interestingly credit supply shocks appear to play less of a role in the Lawson Boom of the late 1980s and in the subsequent recession and slow recovery of the early to mid-1990s. Much of the credit growth here is attributed to a preference or capital market substitution shock (labelled CD in the charts). This reflects the fact that spreads moved relatively little, or if anything, in the same direction as credit during this period. The strong negative impact of capital market substitution shocks during the first half of the 1990s chimes with the evidence that after the recession of the early 1990s non-financial companies were keen to restructure their balance sheets by repaying bank debt and substituting towards capital market finance (see Salmon (1995)).

Charts 8 and 9 show that the standard macroeconomic shocks appear to explain most of the historic movements in GDP but credit supply shocks also appear to have been important, especially over the past 10-15 years. This is clearest when we try to strip out the average monetary policy response in Chart 8. Credit supply shocks were adding to GDP growth during the pre-crisis period and played a significant role in driving weak GDP growth during the financial crisis itself (we quantify this further in the next section). Interestingly Chart 8 shows that monetary policy was moving to offset the impact of those shocks both pre and post-crisis, although the contributions from monetary policy shocks in Chart 8 suggests that the zero bound may have meant the initial response of policy (to all shocks) was lower than that might have been expected from the past. Much of the initial slowdown in growth in late 2008 and early 2009 appears to have been the result of a negative demand shock. That could of course reflect the effect of *overseas* credit supply shocks on world demand as found in Helbling at al. (2010).

Chart 6: Historical decomposition of spreads

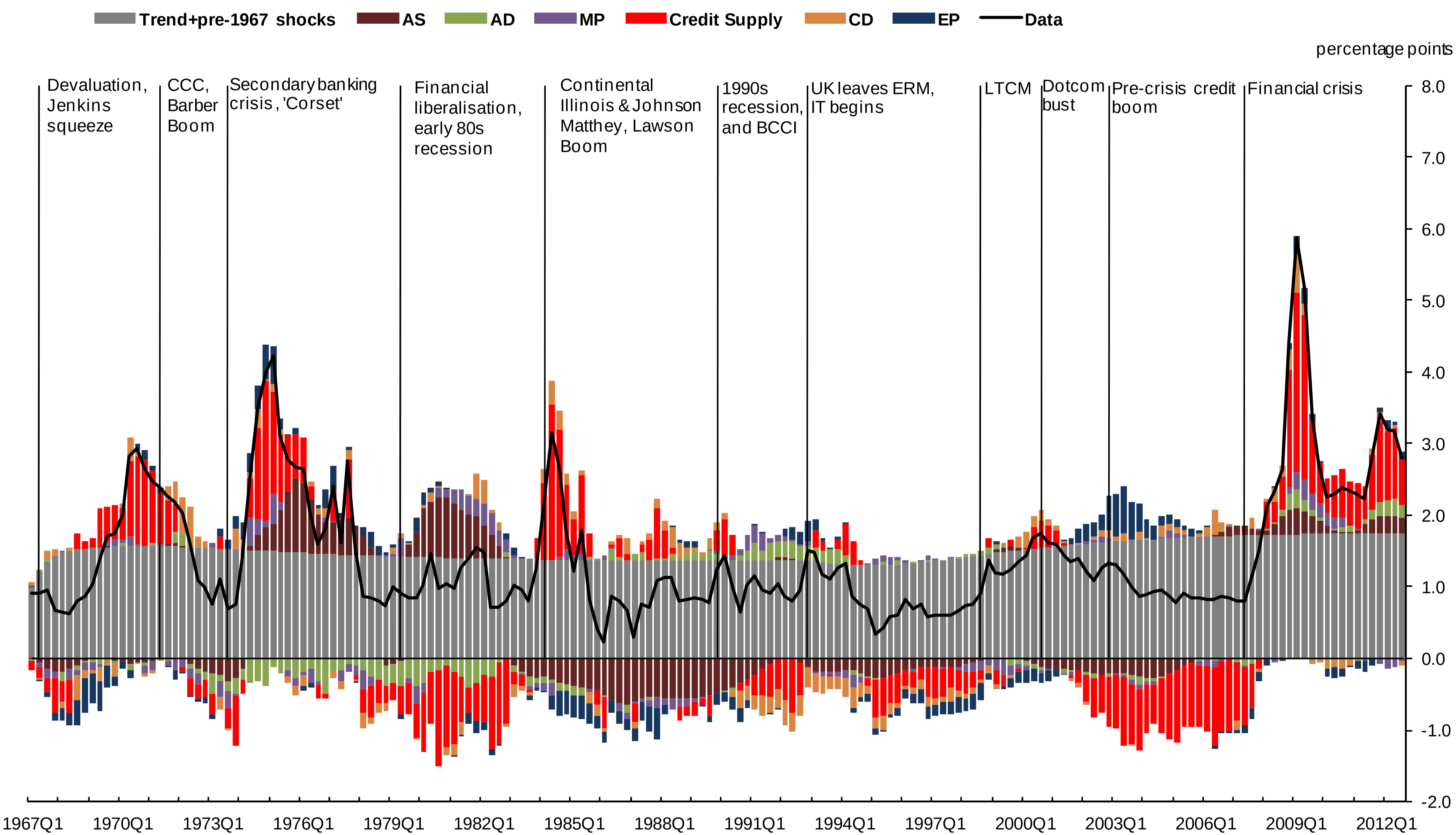


Chart 7a: Historical decomposition of real lending growth

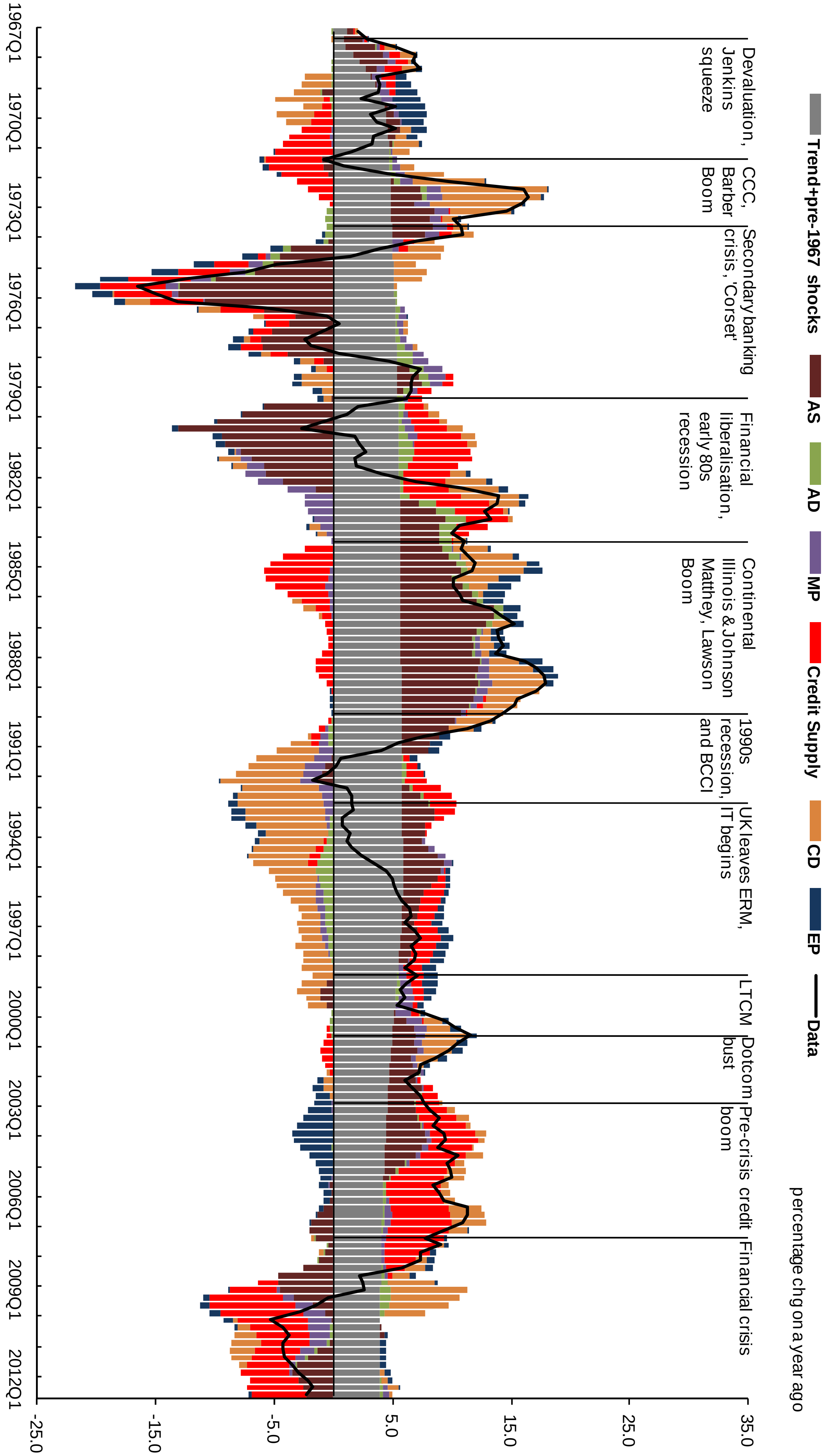


Chart 7b: Historical decomposition of nominal lending growth

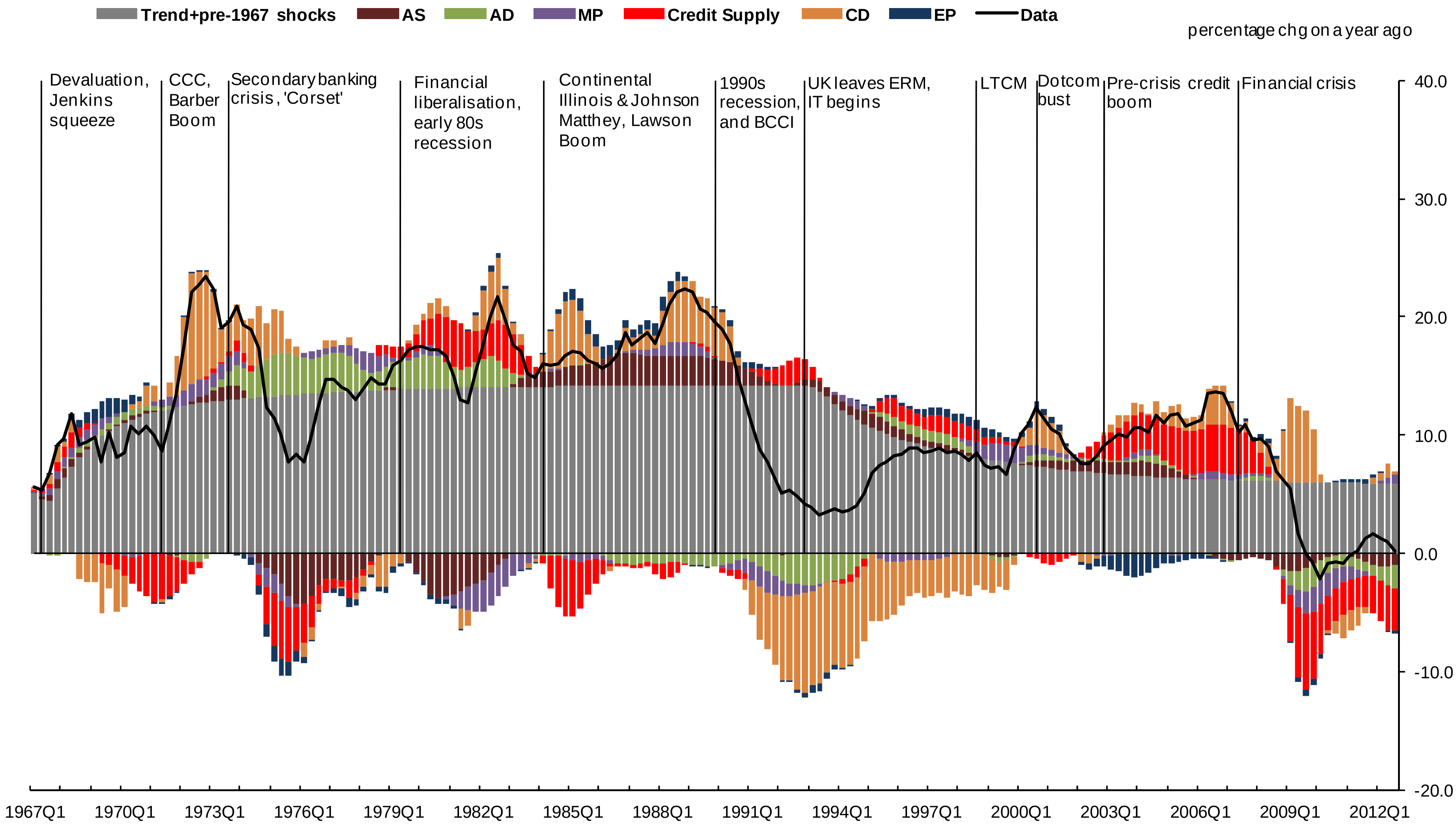


Chart 8: Historical decomposition of GDP growth (with policy response)

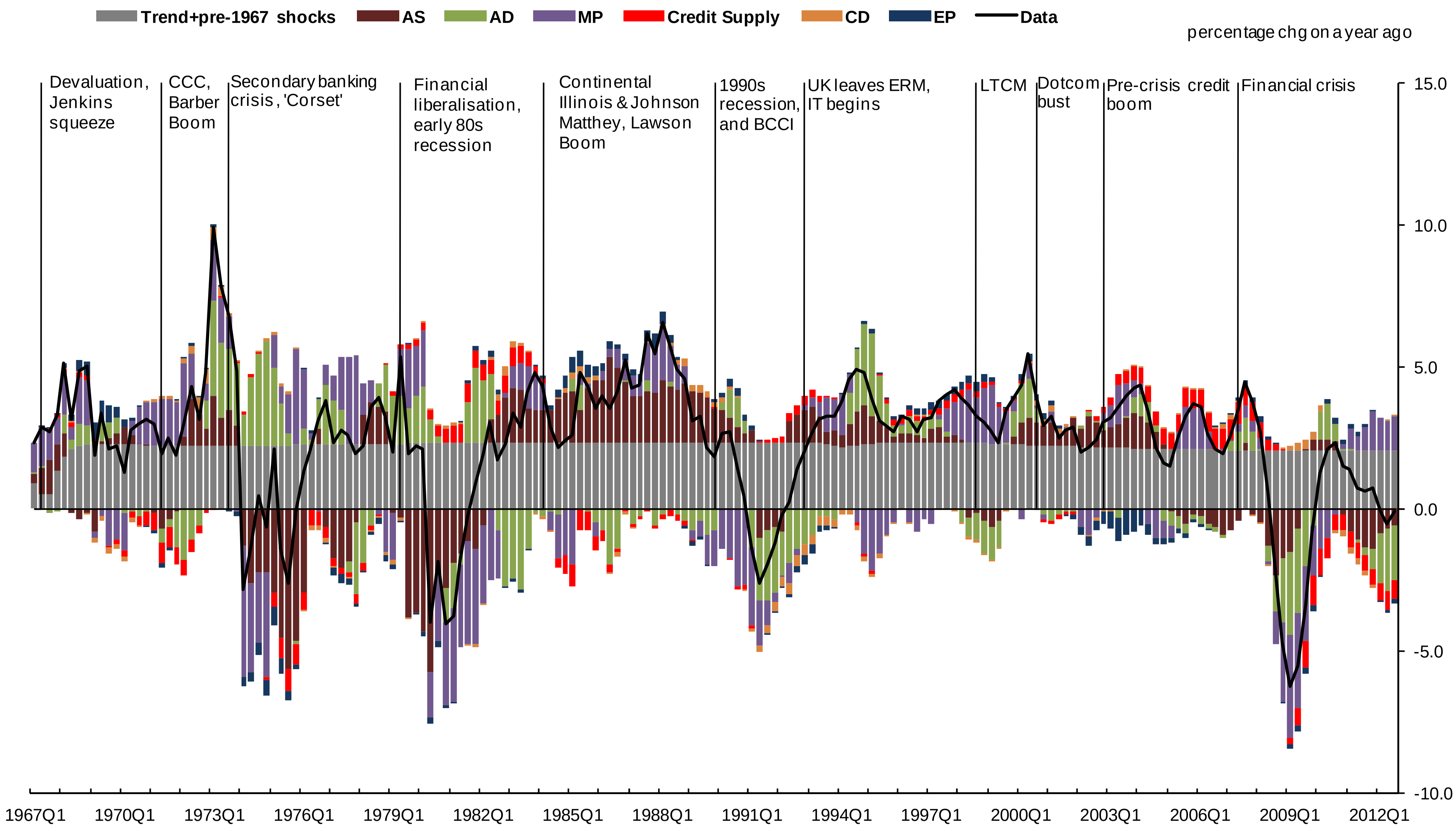


Chart 9: Historical decomposition of GDP growth with no policy response to shocks

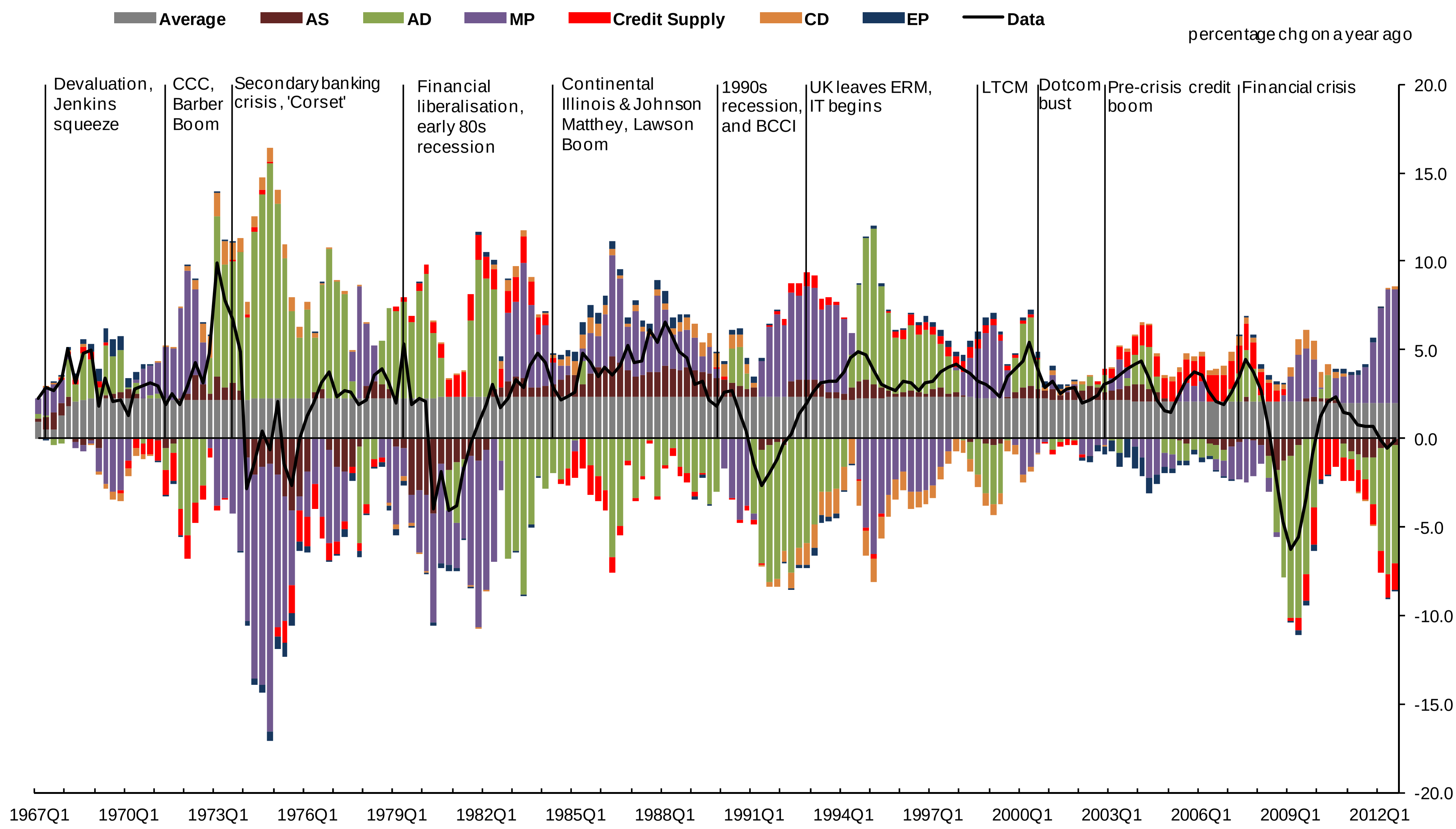
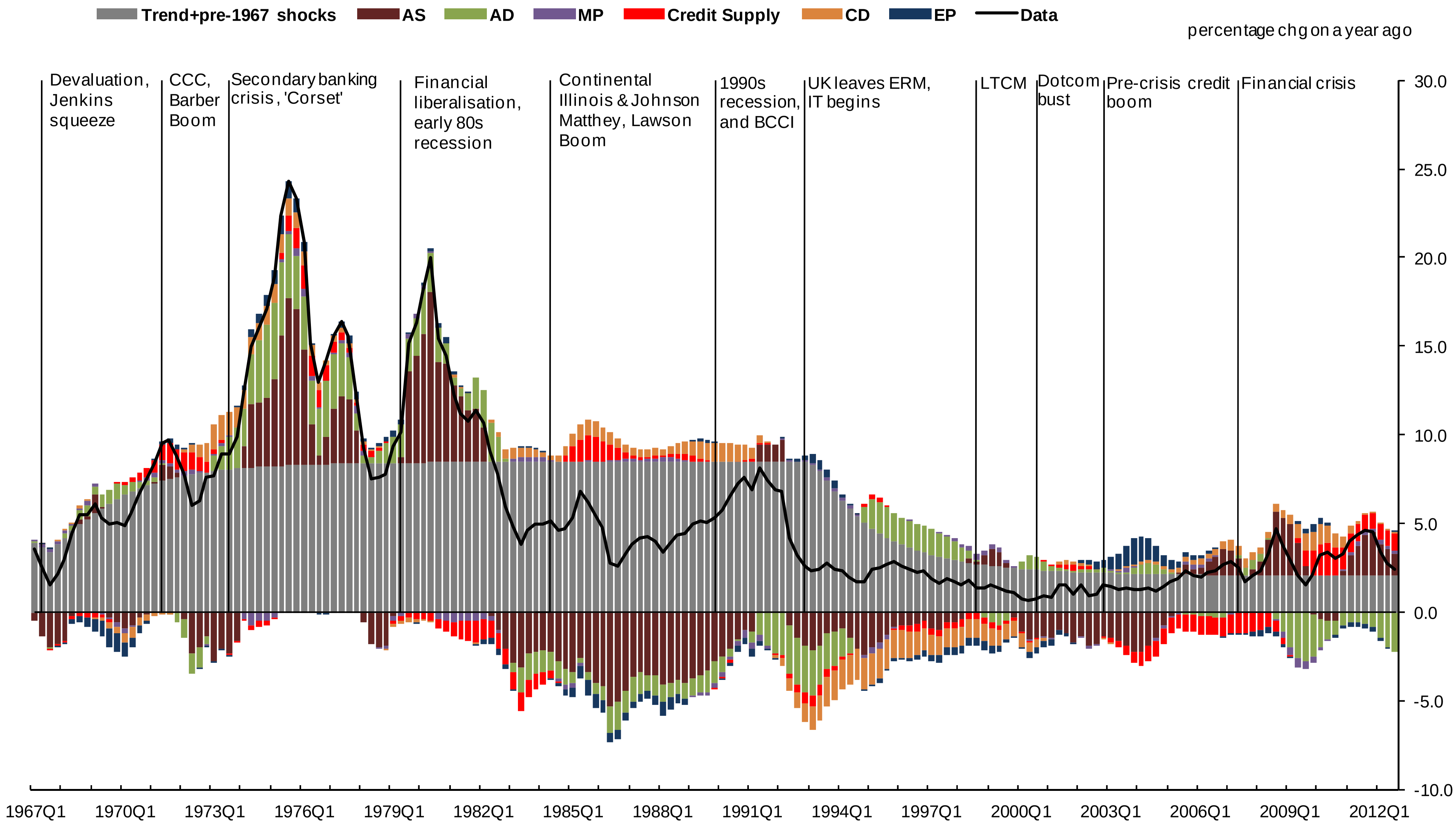


Chart 10: Historical decomposition of CPI inflation



4.2 A quantification of the role of credit supply shocks during recent crisis

In this section we focus in on the recent financial crisis and quantify the role of credit supply shocks. Charts 11 and 12 show decompositions of real M4 lending growth, both with and without a monetary policy response. And in Charts 13 and 14 we put these contributions into nominal space and show simple decompositions of the headline measure of M4 lending into the contribution of credit supply shocks, and the contributions of all the other shocks put together, which we can broadly think of as the combined shocks to credit demand (ie those that affect the demand for credit through affecting the aggregate level of activity and preference/capital market shocks that affect the demand for credit for a given level of activity)[4]. Chart 13 shows the contributions in annual lending growth space while Chart 14 shows contributions to the change in the stock of lending since 2007Q1 relative to its historic trend.

Chart 11: Decomposition of real lending growth – with policy response

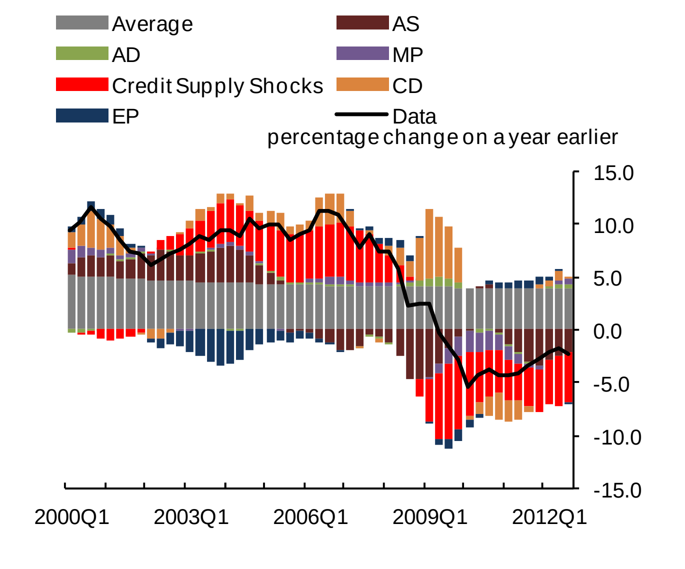


Chart 12: Decomposition of real lending growth – without policy response

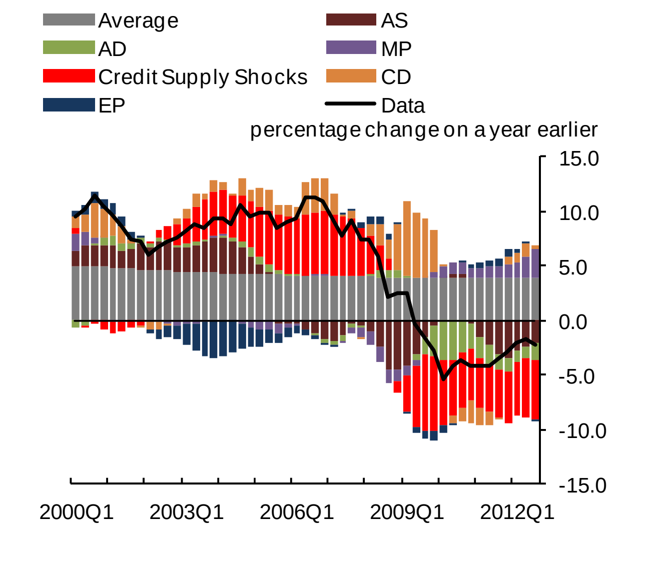


Chart 13: Simple decomposition of nominal M4Lx(ex) growth – without policy response

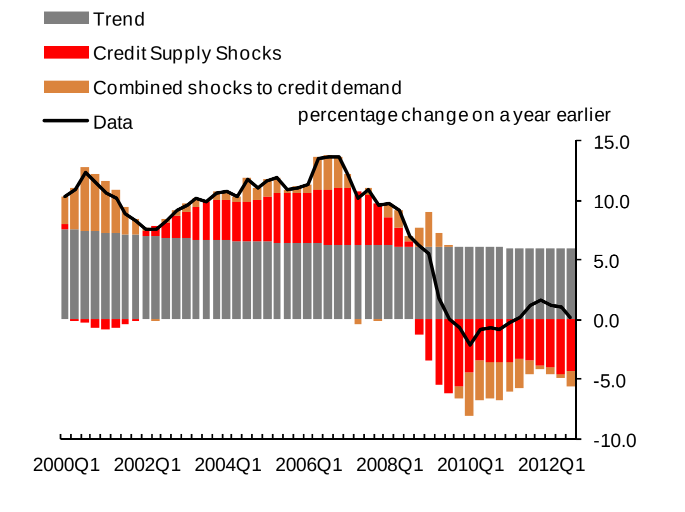
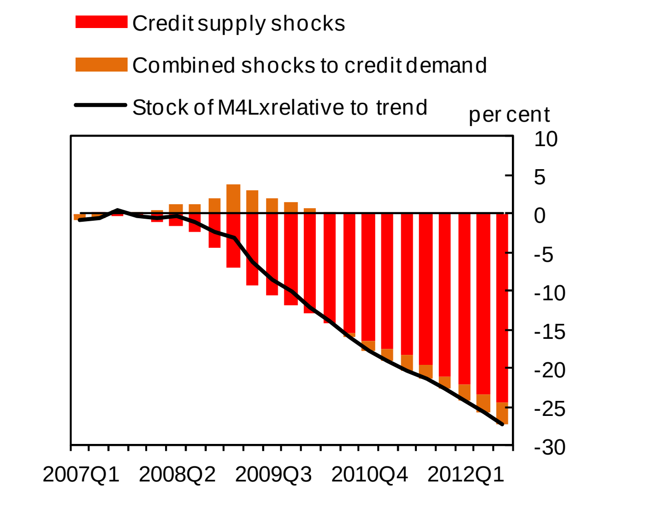


Chart 14: Decomposition of stock of nominal M4Lx(ex) since start of 2007



[4] Both charts show the contribution of credit supply shocks with monetary policy held fixed, so the impact of changes in long-term bond yields are attributed to credit demand as in Chart 10.

The charts indicate that shocks to credit supply rather than credit demand have played the key role in driving movements in lending, both before and after the crisis. Weak demand for credit did play some role in 2010 and 2011, but Chart 14 shows that cumulatively credit supply shocks explain the vast majority of the 25% fall in the stock of credit relative to trend since the start of 2007. This reaffirms the conclusions of Bell and Young (2010) that credit supply shocks played the more important role in holding back lending growth since the start of the crisis.

In terms of the impact of credit supply shocks on GDP, Chart 13 shows that credit supply shocks can explain between a third and a half of the 15-20% fall in GDP relative to its historic trend, depending on whether the response of monetary policy is factored in or not. Chart 14 shows the same chart in levels space. Charts 8 and 9 showed that negative aggregate demand and supply shocks explain the rest of the fall in GDP, though these may plausibly be related to global credit supply shocks which contributed to a collapse in world trade and global demand late in 2008 and early in 2009.

Chart 15: Cumulative impact of credit supply shocks with and without a policy response

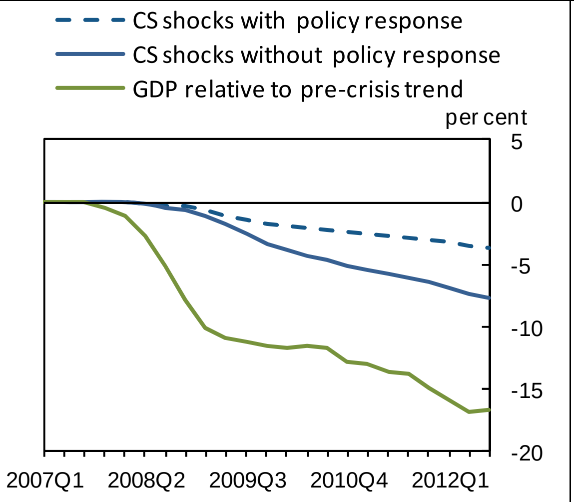
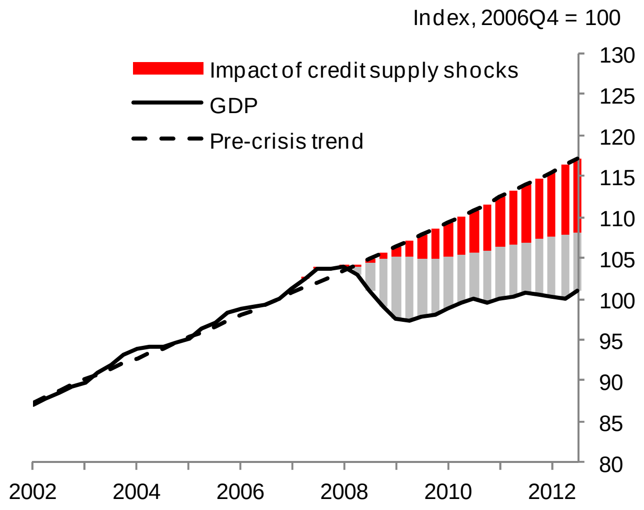


Chart 16: Cumulative impact of credit supply shocks on the GDP gap



5 Robustness and plausibility checks

In this section we check the results of our central case assumptions against two alternative specifications based on different identifying restrictions.

5.1 Alternative timing restrictions

A key identifying restriction in our baseline case is that financial market shocks have no contemporaneous effects on GDP. We test the robustness of this assumption by considering an alternative scheme where this timing restriction is removed and instead we assume financial market variables react to the macroeconomic shocks with a quarter lag. So corporate bond spreads, credit and equity prices only respond to financial market shocks in the first period. These are probably less palatable restrictions for identifying the macroeconomic shocks but it would allow us to gauge how much the contemporaneous timing restriction on the credit supply shock might be understating its impact. The restrictions we impose in this case are shown in Table 3 with the changed restrictions highlighted in bold.

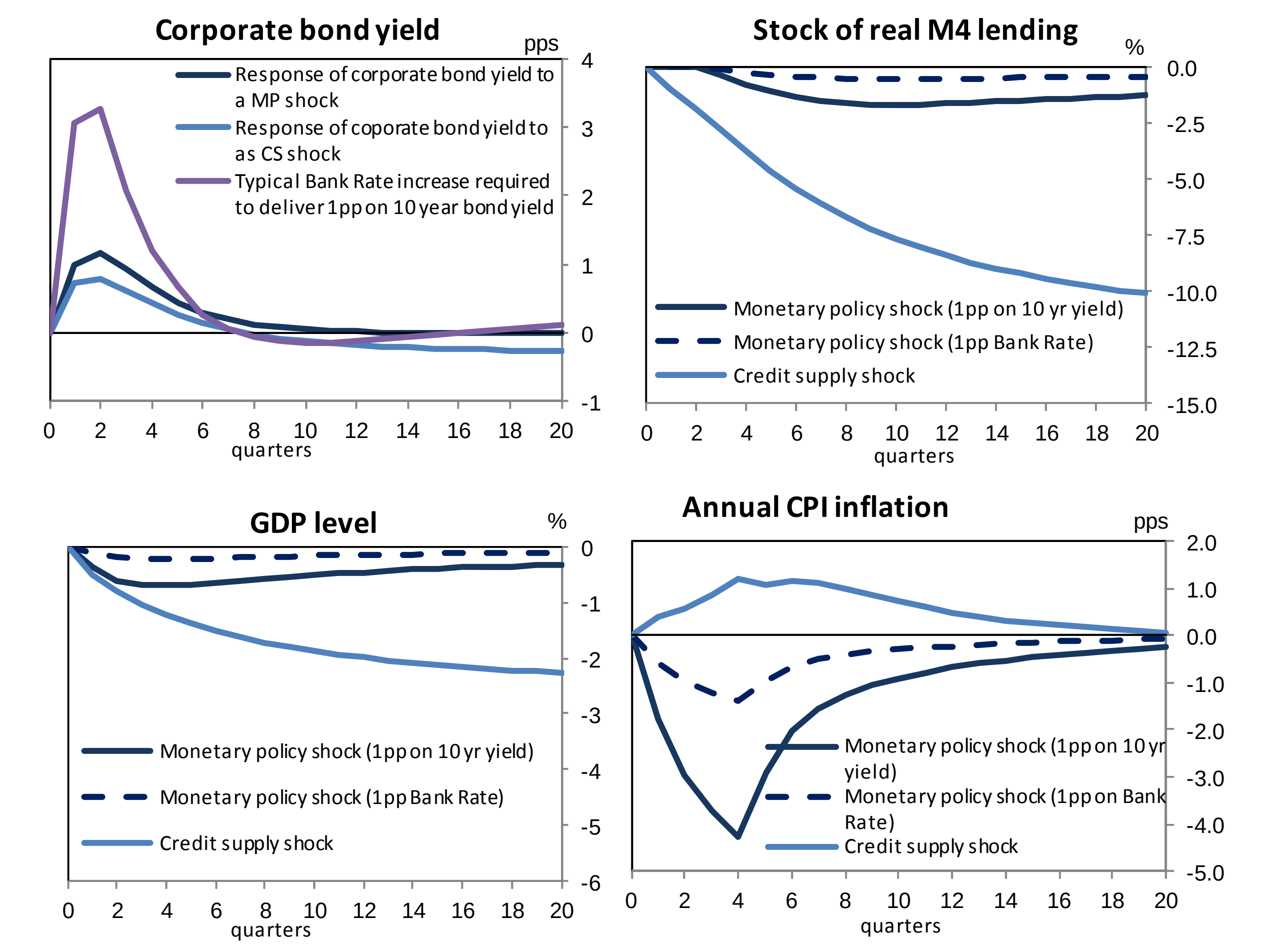
Table 3: Summary of identifying restrictions under alternative timing assumptions

Shock/Variable	CPI inflation	GDP growth	Policy rate	Corporate Bond Spread	M4Lx	Equity prices
Aggregate supply	+	-	?	**0**	**0**	**0**
Aggregate demand	+	+	+	**0**	**0**	**0**
Monetary Policy	+	+	-	**0**	**0**	**0**
Credit supply	**?**	**?**	**?**	+	-	?
Credit demand	**?**	**?**	**?**	+	+	?
Equity price	**?**	**?**	**?**	0	0	1

The restrictions produce similar results to our baseline results for credit supply shocks. Impulse response analysis suggest a credit supply shock pushes up on inflation and has a larger impact on credit than an equivalently-sized monetary policy shock (see Chart 17). The quantitative impact on lending and GDP also looks very similar to our base case.

The monetary policy shock under this identification schema is, however, different to our base case. The GDP impact of a monetary policy response is considerably weaker than a credit supply shock. And the inflation impact is implausibly large relative to the GDP impact. This suggests that the monetary policy shock is quite sensitive to the timing restrictions whereas our credit supply shock looks to have similar quantitative impacts across our different timing specifications.

Chart 17: Credit supply shock compared to a monetary policy shock using alternative timing restrictions



This is reflected in Charts 18 and 19 which show that the quantitative impact of credit supply shocks during the financial crisis is quite similar to our baseline case. Credit supply shocks explain most of the slowdown in lending growth since the start of the crisis. They can also explain around a half of the fall in GDP relative trend, although in this case it matters little if a policy reaction is built in to the decompositions given the weak effect of monetary policy shocks on GDP. So overall our conclusions appear robust to a change in timing restrictions.

Chart 18: Credit supply shocks on real lending growth under alternative timing restrictions

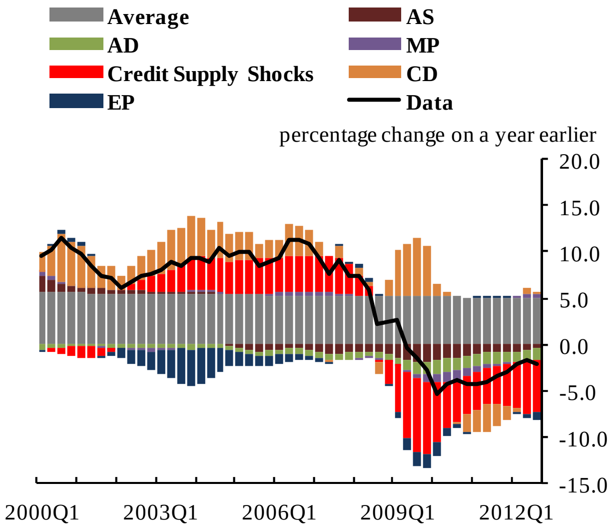
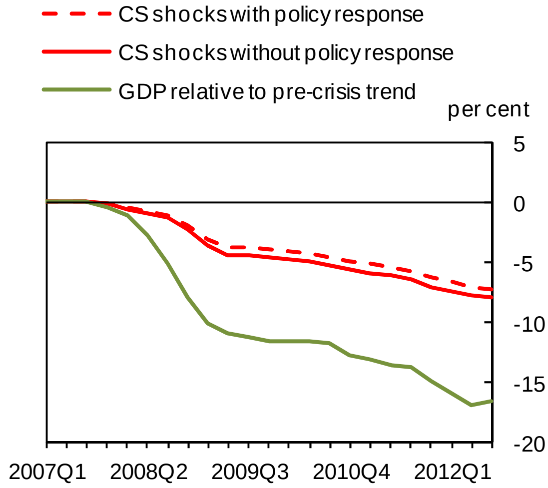


Chart 19: Cumulative impact of credit supply shocks on GDP relative to pre-crisis trends



5.2 Long-run restrictions

A more radical departure from our baseline identifying assumptions is to use long-run restrictions to identify credit supply shocks. As noted earlier our combination of sign and timing restrictions places no long-run restrictions on the impacts of the shocks we have identified. So aggregate demand and monetary policy shocks are allowed to have a permanent effect on output and other real variables even though theory often restricts these shocks (monetary policy shocks in particular) to be neutral in the long run. We also noted earlier that in our central case spreads are treated as a stationary ‘I(0)’ variable while the stock of real M4Lx is treated as a non-stationary ‘I(1)’ variable. So a credit supply shock can only have temporary effect on spreads but can potentially have a long-run impact on the stock lending. That suggests the long-run effect of a credit supply shock on the stock of lending works through a direct quantitative impact on credit rather than through price effects. Theory might also suggest that for credit supply shocks to have a permanent effect on output they must permanently affect the cost of capital for industries reliant on bank credit. Only if credit spreads increased permanently would the demand for capital and steady-state output in bank-reliant industries fall.

To test the sensitivity of these assumptions we adopt an alternative identification approach based on long-run restrictions following Blanchard and Quah (1989) – see Appendix 1 for details. To do this we treat both the policy rate and credit spreads into the VAR as I(1) variables, recalling that both these variables were borderline stationary in the unit roots tests earlier. This means entering both variables into the VAR in first differences.

To identify our six shocks in the Blanchard-Quah framework we adopt the long-run restrictions summarised in Table 4. The table shows how the long-run impact of each shock on the *level* of each variable is restricted. A '*' denotes the impact is unrestricted.

Table 4: Long-run impact matrix

Shock/Variable	Price level	GDP level	Policy rate	Corporate Bond Spread	Stock of real M4Lx	Real Equity price
Aggregate supply	*	*	*	0	*	*
Aggregate demand	*	0	*	0	0	0
Monetary Policy	*	0	0	0	0	0
Credit supply	*	*	*	*	*	*
Credit demand	*	0	*	*	*	0
Equity price	*	0	*	0	0	*

The restrictions are as follows:

- Only credit supply and credit demand shocks are allowed to have a long-run effect on spreads.

- We only allow two shocks to have a long-run effect on output – aggregate supply and credit supply shocks. All other 'demand' shocks are assumed to be neutral on output. The only difference between our credit supply and aggregate supply shocks is that only the former has a long-run effect on spreads. This runs the risk that credit supply shocks that directly affect the quantity of credit independently of credit spreads may possibly get captured in our aggregate supply shock.

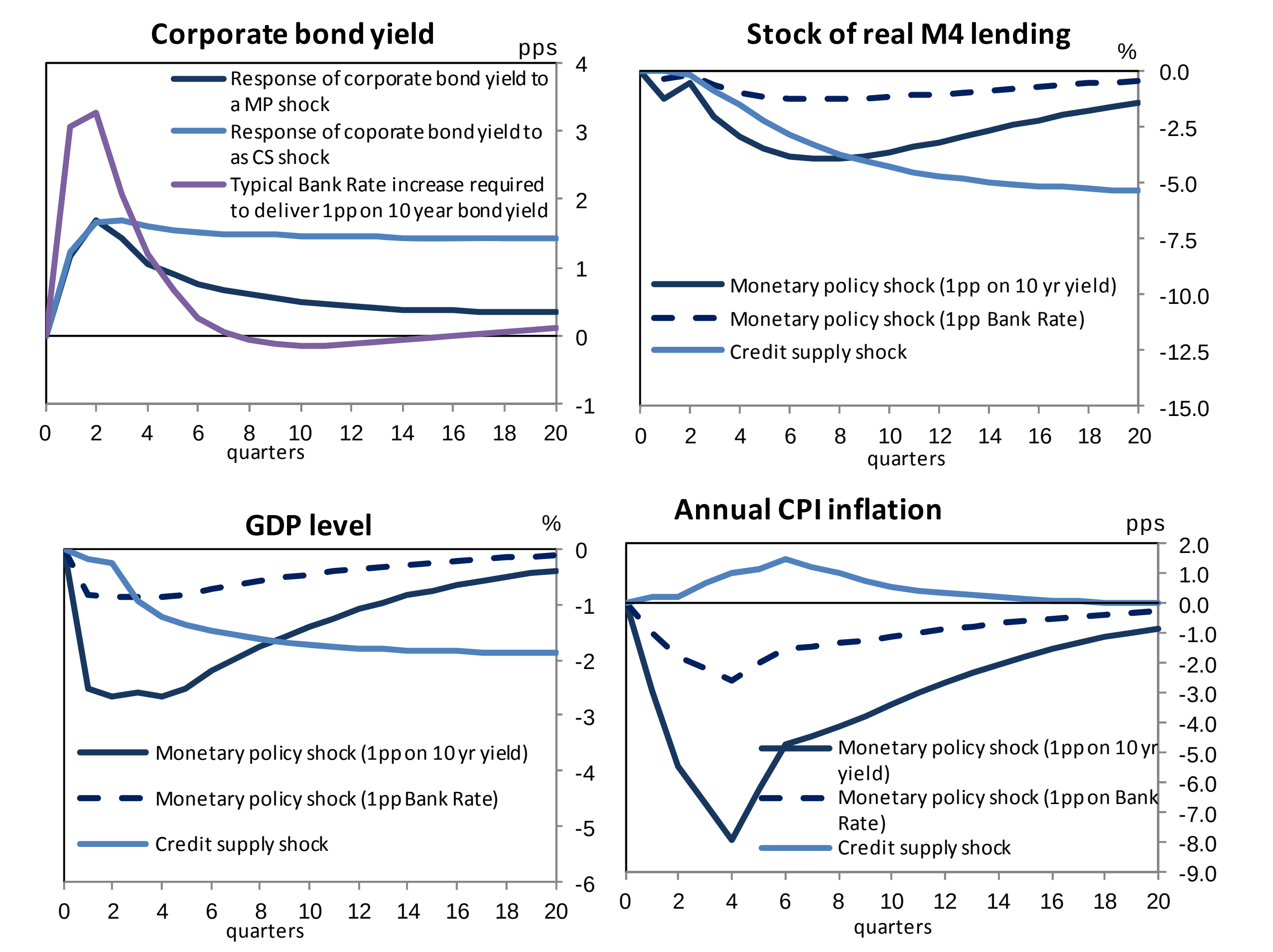
- Monetary policy shocks are differentiated from aggregate demand shocks by assuming they have no long-run effects on real long-term risk-free rates, whereas aggregate demand shocks implicitly include fiscal shocks that might affect the term premium in the long run. In addition out of the 'demand' shocks only an equity price shock is allowed to have a permanent effect on real equity prices.

The results of the long-run restrictions analysis are less compelling than our base case or the alternative restrictions case. Although many of the signs of the impulse responses conform to our baseline case, including importantly the credit supply shocks, some of the relative impacts look implausible. In particular the monetary policy shock is not well-determined relative to the other demand shocks. A relatively small change in long rates has an implausibly large change on inflation suggesting the impact of a policy shock on long-term rates may not be distinguishable from the other demand shocks all of which push GDP and inflation in the same direction. This is similar but more extreme than the alternative timing restrictions. This reaffirms our earlier analysis that the monetary policy shock is quite sensitive to the identification scheme.

Also the responses suggest a tightening of policy in response to a rise in spreads rather than a loosening.

Even so when we try and compare the monetary policy shock with our credit supply shock many of the qualitative results of our base case analysis go through (Chart 20). In particular a credit supply shock that initially increases yields still pushes up on inflation whereas an equivalent monetary policy shock pushes down. Monetary policy shocks also still appear to have a larger initial effect on GDP even though this response is assumed to be neutral in the long run and the credit supply shock is now allowed to affect GDP contemporaneously. Credit supply shocks also still appear to have a larger impact than monetary policy shocks on the stock of real lending although this is partly the direct result of our long-run restrictions because spreads are now permanently affected by a credit supply shock and money supply shocks are restricted not to have a long-run effect on real lending. Notably in this case the ultimate impact of credit supply shocks on the stock of real lending is smaller than our central case even though the spread increase is permanent. So under these restrictions there is indeed less clear evidence of quantity or non-price effects in our credit supply shock, but as noted earlier these may now be reflected in our aggregate supply shock.

Chart 20: Credit supply shock compared to a monetary policy shock using long-run restrictions



How robust do our quantitative conclusions about the role of the credit supply shocks in the financial crisis look under these restrictions ? Charts 21 and 22 compare the historical decomposition of real lending growth and the cumulative impact of credit supply shocks on GDP between our base case assumptions and the long-run restrictions case.

It suggests that the credit supply shocks might explain less of the slowdown in lending growth than in our base case. This is because now the sharp fall in credit spreads observed in 2010 that followed the sharp increase in spreads in 2009 is now interpreted as a positive credit supply shock, rather than the unwinding of a previous negative supply shock. As a result credit supply shocks are assumed to have a positive impact on lending growth in 2010 and early 2011. This turns round again in 2011 when spreads increase again and start to push down on lending growth. In terms of the GDP impact, shown in Chart 22, the initial negative impact of credit supply shocks on GDP looks almost as twice as large as our base case, perhaps reflecting that we are not placing a timing restriction on this shock. The cumulative GDP impact then fades as the positive credit supply shocks in 2010 feed in. Note Chart 22 shows a comparison of the impact with a monetary response built in given the implausibility of the monetary policy shock under long-run restrictions.

Chart 21: Credit supply shocks and real M4 lending growth

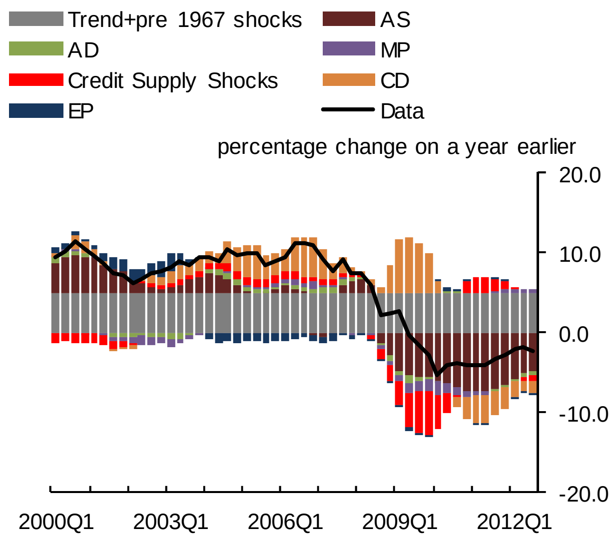
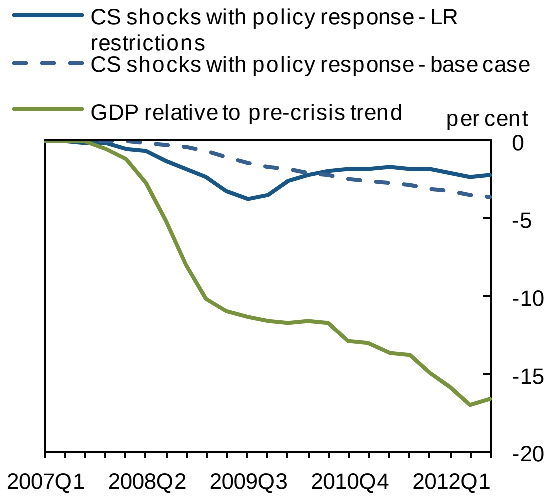


Chart 22: Cumulative impact of credit supply shocks on the GDP gap



Interestingly most of the fall in lending and GDP growth can now be explained by aggregate supply shocks (Chart 21). But, as noted earlier, the only difference between our aggregate supply and credit supply shocks is that only the latter shock is allowed to affect spreads in the long run. That would suggest we might have pushed any direct quantitative effects of credit supply shocks into the aggregate supply shock, which we noted earlier might be the result of imposing our set of restrictions. So the distinction between aggregate and credit supply shocks may be somewhat blurred in this case. Overall this leads us to conclude that the long-run restrictions case does not rule out our baseline result that credit supply shocks might affect the majority of lending and a significant part of the fall in GDP.

6 Conclusions

Our results, based on both the central case assumptions and our various robustness checks, suggest several qualitative and quantitative conclusions.

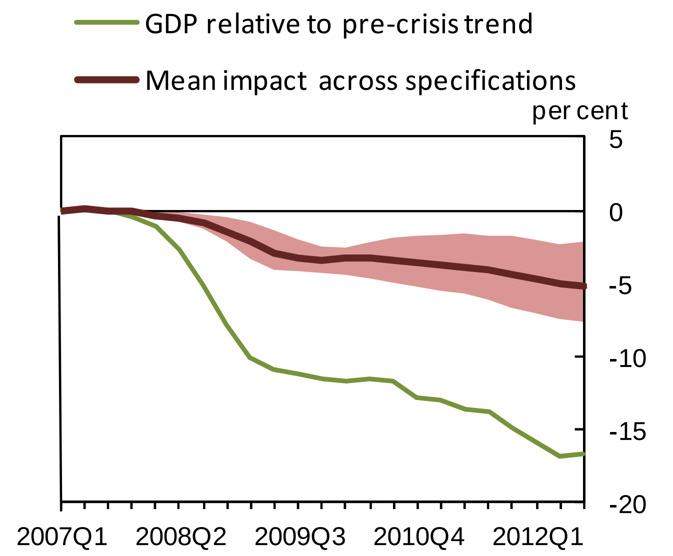
- Credit supply shocks appear to be more like aggregate supply shocks than aggregate demand shocks. A contraction in credit supply pushes down on GDP and up on inflation. That may be due to an exchange rate effect in addition to an effect on potential supply which is plausible given that financial services are an important source of exports for the UK.

- Our results also suggest credit supply shocks appear to have direct quantitative effects working over and above the impact on borrowing rates. Compared with a monetary policy shock that raises loan rates by the same amount a credit supply shock has a larger impact on lending.

- Credit supply shocks appear to explain most of the movements in spreads and borrowing in the lead up to and in the aftermath of the financial crisis. It is true that one of our specifications appears to suggest that aggregate supply shocks were the most important. But we believe that this is because the long-run identifying restrictions that force credit supply shocks to have a permanent effect on spreads may mean that direct quantity restrictions on credit may get captured by aggregate supply shocks. If this is true it reinforces the first two conclusions.

- Since 2007 credit supply shocks can probably explain somewhere between a third and a half of the observed fall in GDP relative to pre-crisis trends. Chart 23 shows the range of impacts across our different identification schemes. The minimum impact suggests credit supply shocks can only explain around 1/8 of the fall but this is based on long-run identifying restrictions which we believe exclude any direct quantity restrictions. The mean and maximum of our specifications, which include quantity effects, would suggest the most likely impact is between 5-8% of the 16% fall in GDP relative to trend depending on how much of the identified impact includes the response of monetary policy which we found difficult to estimate precisely across our specifications.

Chart 23: Impact of credit supply shocks on GDP across specifications



Our results also suggest some avenues for future work. First it might be useful to try and identify credit supply shocks using a combination of sign and long-run restrictions. In this respect it might be possible to apply the less restrictive methods of imposing restrictions over longer horizons suggested by Barsky and Sims (2011) and Francis et al (2012). Second it would be useful to look at a sectoral analysis of credit supply shocks. That may help us understand the reasons behind why credit supply shocks appear similar to aggregate supply shocks. Finally we may want to do a more detailed analysis of the potential time variation in the responses to credit supply shocks using time-varying parameter SVAR techniques with stochastic volatility as used in Kapetanios et al (2012).

Appendix 1: Long-run restrictions methodology

The Blanchard-Quah identification scheme involves placing sufficient zero restrictions on the cumulative long-run impact of each shock in terms of the level of each variable. Given the VAR model in differences:

$$B(L)\Delta X_t = d + \xi_t \tag{3}$$

where $B(L) = I + B_1L + B_2L^2$........

The moving-average representation for each variable (how each variable can be explained in terms of current and lagged shocks) is given by:

$$\Delta X_t = \mu + C(L)\xi_t$$

where $C(L) = B(L)^{-1}$

and this can be transformed into levels space:

$$X_t = X_0 + \mu t + C(1)\sum_{i=0}^{t-1} \varepsilon_{t-i} + C^*(L)\xi_t$$

where $C^*(L) = (1-L)^{-1}[C(L) - C(1)]$ and $C(1)$ is the long-run impact matrix.

As noted earlier, the underlying structural economic shocks η_t are defined as a (linear) combination of the reduced-form errors, $\eta_t = A_0^{-1}\xi_\tau$, then by an appropriate choice of A_0 the structural shocks can be recovered. The relationship between x_t and the underlying shocks is then given by:

$$X_t = X_0 + \mu t + C(1)\, A_0 \sum_{i=0}^{t-1} \eta_{t-i} + C^*(L)\, A_0\eta_t$$

To uniquely identify the n^2 elements of the matrix A_0 requires n^2 independent restrictions. n(n+1)/2 restrictions can be obtained by assuming the structural shocks are independent and have a variance of unity (this implies $A_0 A_0^{'} = \Sigma$ where Σ is the known variance covariance matrix of the reduced-form residuals ε_t). This leaves n(n-1)/2 further restrictions to be imposed . This can be done by imposing long-run restrictions on the shocks. In equation (3) the term *C(1)* A_0 represents the long-run multipliers of the structural shocks η on the level of x_t. So to restrict one of the shocks to have no long-run effect on one of the variables then A_0 would need to be appropriately restricted so that a particular element of C(1) A_0 took the value of zero.

Appendix 2: An error-correction model of 10-year bond yields on Bank Rate

Dependent Variable: Δ(RL)
Method: Least Squares
Sample : 1967Q1 2012Q3
$\Delta(RL) = \alpha_1 + \alpha_2 * \Delta(RS) + \alpha_3 * \Delta(RS(-1)) + \alpha_4 * (RL(-1)-RS(-1))$

	Coefficient	Std. Error	t-Statistic	Prob.
α_1	0.0025	0.0366	0.0693	0.9448
α_2	0.3279	0.0369	8.8821	0.0000
α_3	-0.0767	0.0369	-2.0749	0.0394
α_4	-0.0446	0.0197	-2.2696	0.0244

R-squared	0.3061	Mean dependent var	-0.0277
Adjusted R-squared	0.2945	S.D. dependent var	0.5682

RL is the 10-year bond yield and RS is Bank Rate.

Appendix 3: Cointegration tests

3 variable system of real GDP, real lending and real equity prices (all in logs)

Sample: 1967Q2 2012Q3
Lags interval (in first differences): 1 to 4

Hypothesized No. of CE(s)	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None	19.30	29.68	35.65
At most 1	7.12	15.41	20.04
At most 2	1.21	3.76	6.65

Trace test indicates no cointegration at both 5% and 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

Hypothesized No. of CE(s)	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None	12.18	20.97	25.52
At most 1	5.91	14.07	18.63
At most 2	1.21	3.76	6.65

Max-eigenvalue test indicates no cointegration at both 5% and 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

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