CESifo Working Papers
www.cesifo.org/wp

Macroeconomic Fluctuations in a Stylized DSGE Model with Disequilibrium Dynamics

Bas van Aarle

CESIFO WORKING PAPER NO. 4017
CATEGORY 6: FISCAL POLICY, MACROECONOMICS AND GROWTH
DECEMBER 2012

CESifo *Working Paper No. 4017*

Macroeconomic Fluctuations in a Stylized DSGE Model with Disequilibrium Dynamics

Abstract

This study develops a stylised DSGE model, that departs in one aspect: it replaces the general equilibrium approach by disequilibrium economics. In this way, richer macroeconomic adjustment dynamics result, as it is not necessary to assume that goods and labour markets continuously clear. The disequilibrium dynamics – in the form of regime-dependent output and employment fluctuations, wage and price adjustments-complicate (viz. enrich) the decision making problems faced by the fiscal and monetary policymakers. In particular the possibility of (multiple) regime switches implies the need for deeper analysis and monitoring of the disequilibrium mechanisms when designing and implementing monetary and fiscal policies.

JEL-Code: C220, E320, E660, F420.

Keywords: disequilibrium analysis, DSGE model, macroeconomic policy.

Bas van Aarle
Hasselt University
Agoralaan C52
3590 Hasselt
Belgium
bas.vanaarle@uhasselt.be

Paper prepared for the conference “Beyond the short run: Productivity growth, market imperfections and macroeconomic disequilibrium.”, held at the Sapienza Universita di Roma, May 11-12, 2012. Suggestions by conference participants are gratefully acknowledged.

1. Introduction

The financial and economic crisis that has struck the global economy since the second halve of 2008, has led to a renewed interest in macroeconomic adjustment and macroeconomic management. At the paradigmatic level, standard approaches -be they more of a neo-classical or Keynesian nature- appear to be inadequate to explain the size and persistence of fluctuations seen during the crisis. Even the recent generation of very subtle and detailed DSGE (also often referred to as New Keynesian) models appear to be able to deliver only partially adequate explanations for the observed effects of the financial crisis. At the policy level, unconventional monetary and fiscal policy measures like the ultra-loose quantitative easing in the US and the large fiscal stringency plans in Europe appeared to not have had the desired effects and in fact are blamed to have aggravated the slowdown.

This paper seeks to fill a paradigmatic black hole by integrating the earlier literature on disequilibrium analysis and more modern dynamic macroeconomics. The strengths of disequilibrium macroeconomics are that it does not need to rely on general equilibrium principles and allows the possibility that the economy is moving through different regimes over time, e.g. from a Keynesian to a Neo-Classical regime and back. The strengths of modern dynamic macroeconomic models of the DSGE type are that they incorporate the need to include microeconomic foundations and to allow for rational, forward-looking agents that scrutiny the macroeconomic policymakers and their actions.

The motivation of this paper is not only to analyse the interesting results of such an integration of disequilibrium analysis into modern dynamic macroeconomics. Using this approach, we also want to provide the reader with new perspectives when studying the current financial and economic crisis and the policy reactions observed. In fact, it is quite possible we like to argue, that the large macroeconomic adjustments and the less effective policy strategies we observe, are also caused by regime switches that occur along the way. E.g. an expansionary fiscal policy that would seem effective in a Keynesian regime becomes rather ineffective in a Classical or Labour Hoarding regime. Moreover, such regime switches should not be seen as rare events, but can take place quite frequently, our examples suggest. Regime switches imply that we do not observe the smooth, linear adjustment dynamics, typical for DSGE models, but rather non-linear "sawed" adjustments that are hard to predict.

Section 2 summarizes the main principles from the literature on disequilibrium macroeconomics. Section 3 develops a model that incorporates disequilibrium analysis into a stylized DSGE model. Section 4 uses simulation examples to study the dynamic and stochastic properties of the macroeconomic fluctuations produced by macroeconomic shocks in the presence such short-term macroeconomic disequilibria. Section 5 concludes the paper by summarising the main findings.

2. Disequilibrium macroeconomics

The non-Walrasian, disequilibrium approach to macroeconomics received a significant, but relatively short-lived interest in the 1970s and early 1980s, after which macroeconomic research rather abruptly shifted its interest to new Classical and new Keynesian economics that is based on the assumption of market-clearing and some degree of (downward) rigidity in prices and/or wages, leading to short-run fluctuations in output and unemployment around their potential. The now standard dynamic, stochastic, general equilibrium (DSGE) model combines the new Classical and new Keynesian insights and provides theoretical and empirical rigour in its applications by working out microeconomic foundations and including rational agents.[1]

[1] See e.g. Clarida et al. (1999) and Woodford (2003) for all details on DSGE modeling and empirical verification.

However, one limitation of DSGE models remains their reliance on the general equilibrium assumption: these models ignore any possible disequilibria in labour and goods markets, as exactly stressed in the earlier disequilibrium models. An interesting question remains if we can enrich these modern mainstream macroeconomic models with the insights from the earlier disequilibrium literature.

The disequilibrium approach does not rely on the general equilibrium assumption and instead considers the possibility of non-market clearing, -i.e. persistent divergence between supply and demand, implying rationing by the short side of the market-, to explain unemployment and business cycle fluctuations[2]. It defines regimes of disequilibrium and analyzes disequilibria as a result of shocks, policy adjustments and wage and price adjustments. In the absence of the Walrasian auctioneer, persistent wage and price rigidities exist in the short-run. Prices and wages will follow 'the law of supply and demand' in the longer-run: prices eventually increase when demand exceeds supply and fall when there is excess supply. The disequilibrium approach therefore includes wage and price adjustments similar as these in the DSGE models, even if interpretations are different given the presence of different disequilibrium regimes.

It seems interesting and potentially useful to apply the disequilibrium approach also to DSGE models since the latter are build on the restrictive assumption of continuous equality of demand and supply in the goods and labour market. The more so because the principles of disequilibrium are straightforward and intuitive.

The basic disequilibrium framework in the labour market is given by the (notional) labour demand and labour supply functions, the short-side principle determining actual employment, and a nominal wage adjustment equation that incorporates the excess labour as its main element. For the goods market a similar setup combines the (notional) aggregate demand and supply functions, the short-side principle to determine output, and a price adjustment function. The short-side principle requires that effective employment and production are determined by the minimum of supply and demand in the labour viz. goods market. Excess demand (supply) is the amount by which demand (supply) exceeds supply (demand). The nominal wage adjustment (price adjustment) function determines that wages adjust to any (ex ante) excess demand or supply in the labour market. Similarly, prices adjust to an excess demand or supply in the goods market.[3] This process of adjustment of wages and prices to disequilibria is often referred to as the Bowden-process. Important for the adjustment dynamics is also knowledge about the adjustment speed of prices and wages. In the "orthodox Keynesian" case prices adjust faster than wages, while in the "Neo-Keynesian" case, wages adjust faster than prices. Both case differ as a result in the adjust of real wages after a shock.

Disequilibrium analysis enables to distinguish four different regimes: (i) Keynesian unemployment is characterised by excess supply in the goods and labour market, (ii) Classical unemployment is characterised by excess demand in the goods market and excess supply in the labour market[4], (iii) repressed inflation occurs in case of excess demand in both the goods and labour market and (iv) a labour hoarding regime with excess supply in the goods market and excess demand in the labour market.

Each regime has also its own policy prescriptions. The Keynesian unemployment regime focuses on monetary and fiscal stimuli to increase output and employment back to equilibrium as it presumes that the equilibrating force from adjustment of prices and wages to be inherently slow. The Classical unemployment regime concentrates on reducing real wages to increase employment; reducing taxes on labour income contributes to this. The Repressed Inflation regime requires restrictive monetary and fiscal policies to reduce inflation. The labour hoarding regime needs an increase in real wages to restore equilibrium in goods and labour markets.

[2] See e.g. Barro and Grossman (1971), Grossman (1971), (1973), Malinvaud (1982) and Benassy (1975) on the foundations of disequilibrium analysis. A fully worked out macro-econometric disequilibrium model is found in Arcand and Brezis (1993).
[3] Including disequilibria in the capital market as a third source of disequilibria would further extend and complicate the analysis and will not be considered here.

Complications for the policymakers also arise from the possibility –or likeliness- that the economy moves over time from one regime to another, implying that policies that would seem adequate before, become much less so after the switch. We find indeed that regime switches occur quite often in simulations with our model and that they change the adjustment dynamics in subtle rather than in an abrupt as the term regime switch might suggest. A disequilibrium model with regime switches behaves in a intrinsically nonlinear manner around regime switches. Its adjustment dynamics are therefore qualitatively different from the linear adjustment dynamics of a typical DSGE model and produces typically different policy prescriptions.

3. Setting up a stylized DSGE model with disequilibrium regimes

The previous section summarized briefly the main principles of disequilibrium analysis. In this section we build these principles into a stylized DSGE model. Such models work out –with more or less micro details- three basic building blocks: (i) aggregate demand, (ii) aggregate supply, (iii) macroeconomic policy management. See e.g. Sbordone et al. (2010) and Erceg et al. (2000) for an insightful introduction to DSGE modelling. The smaller DSGE models can be summarized by three reduced-form dynamic relations: the dynamic IS curve, the New Keynesian Phillips curve and a (set of) dynamic policy reaction function(s), see e.g. Svensson (2000) and Soederstrom et al. (2005) for insightful examples that start as our point of reference.

The dynamic IS curve summarizes the aggregate goods demand in the economy:

$$y_t^d = \psi y_{t-1}^d + (1-\psi) E_t y_{t+1}^d - \alpha(i_t - E_t \pi_{t+1} - \bar{r}) - \eta d_t^P + v_t^d \qquad (1)$$

in which y denotes (real) output, i the short-term nominal interest rate, π the rate of inflation in the general price level. The primary fiscal deficit, d^P, equals the primary fiscal balances, government revenues, f, minus non-interest government spending, g: $d^P = g - f$. $\bar{r}$ is the equilibrium real interest rate. v^d is an aggregate demand shock. Variables are given in logarithms and refer to deviations from an initial steady-state normalized to zero for simplicity. The subscript t refers to period t. In this reduced form output depends on past output, expected future output, the real interest rate (expressed as a deviation from the equilibrium real interest rate), net government spending, and a demand shock[5]. The backward-looking component in the IS curve results from "habit formation" in consumption decisions[6]. The forward-looking part is produced by rational, intertemporally maximizing agents that apply the principles of optimal "consumption smoothing.

Aggregate supply of goods is produced using a linear production function. Since capital is held constant for simplicity, labour, l_t, is the only flexible input in the production function; moreover supply is subject to stochastic technology/productivity shocks v^a.

$$y_t^s = l_t + v_t^a \qquad (2)$$

Disequilibrium analysis allows that aggregate demand and supply do not match: output is determined by the minimum rule/short-side principle referred to in Section 2: actual production is determined by the short side of the goods market (implying that demand or supply is "effective" or "notional" depending on whether it is rationed or not):

$$y_t = min(y_t^d, y_t^s) \qquad (3)$$

---

[4] The extreme form of the Classical unemployment regime represents stagflation with increasing unemployment and high inflation.

[5] All macroeconomic shocks -demand shocks (v^d), cost-push shocks (v^p), wage shocks (v^w) fiscal shocks ($v^{f,g}$), supply shocks (v^a), labour demand and labour supply shocks, ($v^{ld,ls}$) and interest rate shocks (v^i)- are all assumed to follow stationary AR(1) processes, where all innovations are white noise innovations, and all innovations are assumed to be contemporaneously uncorrelated.

[6] In related interpretation this fraction of consumers refers to the group of consumers that are liquity and credit constrained or to agents that display 'adaptive learning' behaviour or other types of imperfect information, see e.g. Milani (2009) or De Grauwe .

The difference between demand and supply is referred to as excess supply. It acts as a measure of the degree of disequilibrium/rationing in the goods market:

$$y_t^{exc} = y_t^s - y_t^d \tag{4}$$

In the labour market, similar mechanisms operate as in the goods market, including the disequilibrium dynamics. Labour supply and labour demand are determined by the producer post-tax real wage costs viz. consumers post-tax wage income and are subject to stochastic disturbances:

$$l_t^d = -\beta(\, w_t - p_t + f_t\,) + v_t^{ld} \tag{5}$$

$$l_t^s = \zeta(\, w_t - p_t - f_t\,) + v_t^{ls} \tag{6}$$

Actual employment is determined by the short side of the labour market: (implying that labour demand or supply is "effective" or "notional" depending on whether it is rationed or not):

$$l_t = min(\, l_t^d, l_t^s\,) \tag{7}$$

The difference between labour demand and labour supply is referred to as excess labour supply. It acts as a measure of the degree of disequilibrium/rationing in the labour market viz. unemployment:

$$l_t^{exc} = l_t^s - l_t^d \tag{8}$$

The Walrasian equilibrium only occurs when any excess supply or demand in the labour and goods market is removed ($l_t^{exc} = y_t^{exc} = 0$)[7]. In the absence of further shocks, prices and wages in the Walrasian equilibrium remain constant. Outside the Walrasian equilibrium, disequilibrium analysis relates price and wage adjustment to the disequilibria in the goods and labour market as defined above. It predicts that in principle prices will rise (decrease) as a reaction to excess demand (supply) in the goods market. Similarly, in the labour market, wages will rise (decrease) as a reaction to excess demand (supply) in the labour market. Depending upon the size of the elasticity of prices (wages) to excess supply in the goods (labour) market, this adjustment may take a shorter or longer period of time and be complicated by regime switches that could occur.

We can summarize the price and wage adjustment/setting behaviour in the form of Phillips-curves that are similar to the ones now standard in equilibrium macroeconomics, in particular in the DSGE frameworks. Price inflation is given by hybrid Phillips-curves which contain elements of both forward and backward-looking price setting. In addition, demand-pull and cost-push factors (in particular increase in taxes) may affect inflation,

$$\pi_t^p = \omega^p E_t \pi_{t+1}^p + (1-\omega^p)\pi_{t-1}^p - \gamma^p y_t^{exc} + \sigma^p(\, f_t - f_{t-1}\,) + v_t^p \tag{9}$$

Inflation equals the first difference of the general price level and is assumed to be a function of past inflation, expected future inflation, excess demand (4)[8], -reflecting demand pull inflation- taxes, and cost push shocks (or "mark-up" shocks) v^p. If $\omega = 0$, we obtain the backward-looking Phillips curve, if $\omega = 0$, on the other hand, we obtain the forward-looking New-Keynesian Phillips curve, the hybrid Phillips curve results if ω lies in between 0 and 1. It assumes that both backward and forward-looking price setting are present, reflecting e.g. learning effects, staggered contracts or other institutional arrangements that affect pricing behaviour.

Wage inflation/wage setting is given by a similar hybrid Phillips-curve,

$$\pi_t^w = \omega^w E_t \pi_{t+1}^w + (1-\omega^w)\pi_{t-1}^w - \gamma^w l_t^{exc} + \sigma^w(\, f_t - f_{t-1}\,) + v_t^w \tag{10}$$

[7] Clearly, one would like to think of the Walrasian equilibrium as a unique, and stable steady-state of the model. In the absence of externalities, coordination failures and other types of inefficiencies it would result from the invisible hand of the Walrasian auctioneer and would also act as a Nash equilibrium. Picard (1993) reviews in detail the microeconomic foundations of disequilibrium models and the stability of adjustment in different regimes.

[8] The role of excess supply is here therefore relatively similar as the role of the output gap in the standard New-Keynesian Phillips curves in the literature.

implying wage inflation is driven by past and expected wage inflation, excess supply of labour (8), taxes and wage shocks v^w.

Monetary policy is set according to a standard simple Taylor rule of the following form:

$$i_t = \lambda_i i_{t-1} + (1-\lambda_i)\left(\bar{i} + \phi_i(\pi_t - \bar{\pi}) + \chi_i(y_t - \bar{y}_t)\right) + v_t^i \tag{11}$$

with the target interest rate being equal to the equilibrium real interest plus the inflation target: $\bar{i} = \bar{r} + \bar{\pi}$. The feedback on the output gap –the difference between current output and the potential output level[9]- and inflation are standard in arguments of the Taylor rule. The preference for instrument smoothing is measured by the value of λ_i, where $0 \leq \lambda_i \leq 1$. If λ_i goes to zero the original Taylor rule, which ignores instrument-smoothing objectives, is obtained. If λ_i goes to one, monetary policy no longer reacts to current inflation and output.

Concerning fiscal policy, we assume that government spending and tax revenues are also determined by simple autoregressive fiscal policy rules that relate government spending/fiscal revenues to past levels, the cyclical fiscal stance -measuring the automatic stabilizers-, the level of government debt and the occurrence of stochastic spending and revenue shocks, u^g and u^f:

$$g_t = \lambda_g g_{t-1} + (1-\lambda_g)(\bar{g} - \chi_g y_t - \delta_g(d_t - \bar{d})) + v_t^g \tag{12}$$

$$f_t = \lambda_f f_{t-1} + (1-\lambda_f)(\bar{f} + \chi_f y_t + \delta_f(d_t - \bar{d})) + v_t^f \tag{13}$$

where $0 \leq \lambda_g, \lambda_f \leq 1$.

The fiscal policy rules enables to represent in the model -albeit in a highly stylized way- the various budgetary rules and strategies one may observe in practice and we can also relate the combination of spending and revenue rules with the provisions in the Stability and Growth Pact concerning the fiscal deficit. If $\lambda_{g,f} = 0$ fiscal flexibility at a maximum and the fiscal balance only driven by the automatic stabilizers. If $\lambda_{g,f}$ increases, fiscal flexibility declines implying more persistence in fiscal adjustments. In the limiting case where $\lambda_{g,f} = 1$, fiscal deficits do not adjust at all over time. The budgetary target $\bar{f} - \bar{g}$ can be thought e.g. as being the "close-to balance or in surplus medium term objective", reflecting a preference for long-run sustainability and neutrality.[10] The concern about debt stabilizaton is reflected in the δ's that measure the feedback of the debt level on government primary spending and revenues.

Debt dynamics are determined by the dynamic government budget constraints which relates the stock of government debt, *b*, to its past level and the deficit *d*. The deficit consists of by definition of the interest payments plus the primary deficit, the difference between government spending and revenues,

$$b_t = (1 + i_t - \pi_t) b_{t-1} - d_t^P \tag{14}$$

Interest payments on government debt equal the stock of outstanding debt at the start of the period times the difference between the nominal interest rate and inflation.

Fiscal consolidation efforts can take various forms even in our small model: a reduction in government spending vs a reduction of government revenues, introduction of a lower debt target and changes in the parameters of the fiscal rules, e.g. to make government spending or government revenues more or less flexible and change the sensitiveness wrt output and government debt.

[9] Potential output equals the equilibrium amount of output that can be produced given the current technology with production factors used at full capacity, $\bar{y}=a\bar{l}$ where $\bar{l}$ denotes the full-employment level of employment. DSGE models analyse the fluctuations around potential output in the presence of price and wage rigidities but maintaining a general equilibrium assumption, in contrast with disequilibrium macroeconomics.

[10] Alternatively, one can interprete the budgetary target as a concrete number, -e.g. the 3% deficit criterion of the Maastricht Treaty- and see to which extent automatic stabilizers and debt stabilizers would lead to deviations. The build-in flexibility in the Stability Pact relies on allowing as much as possible the workings of the automatic stabilizers in the short-run.

4. Simulations with the NK disequilibrium model

This section uses simulations to illustrate a number of insights that can be obtained from the model introduced in Section 3. In these simulations we in particular want to obtain insights into the possible effects of fiscal consolidation strategies and macroeconomic shocks. We simulate the effects of various macroeconomic shocks: (i) fiscal policy innovations, (ii) monetary policy shocks, (iii) wage shocks (iv) productivity shocks and (v) demand shocks. All shocks will be unanticipated and hit the economy in period 1. The dynamic stochastic simulations of the shocks provide insights into (a) impulse response functions that give the dynamics adjustments resulting from the shocks, including the transmission of macroeconomic policies and (b) variances and welfare losses resulting from the shocks, allowing to investigate into more detail aspects of volatility and efficiency. We will concentrate here on the impulse response functions as they provide insight on the adjustments produced by the model as a result of stochastic shocks or policy innovations that have occurred.

Underlying all the simulations in this section is a set of baseline model parameters (see Table 1). In the absence of estimated parameters of our model, we rely on this set of baseline guesstimates of these parameters, having an economy like the euro area economy in mind as an example. This paper does not attempt itself to estimate the model for the euro area, but we choose this set of baseline parameters broadly consistent with estimated euro area DSGE models such as the ECB's Area-Wide Model (Dieppe and Henry (2004) and Coenen et al. (2008)) and the Smets and Wouters (2003) model.

ψ	0.3	α	0.05	η	1.0
β	0.15	ζ	0.05		
ω^p	0.5	γ^p	0.1	σ^p	0.5
ω^w	0.5	γ^w	0.05	σ^w	0.4
λ_i	0.5			ξ	0.0
λ_g	0.5	ϕ_i	1.5	χ_i	0.5
λ_f	0.5	δ_g	0.05	χ_g	0.25
		δ_f	0.05	χ_f	0.25
$\bar{g},\bar{f},\bar{d},\bar{b}$	0	ρ^v	0.0	$\bar{\pi},\bar{r},\bar{i}$	0

Table 1 Baseline parameters

The baseline parameters concern: (i) the hybrid IS and Phillips curves and, (ii) parameters that characterize monetary and fiscal policy rules, (iii) assumptions on variances and autocorrelations of shocks and policy preferences. Empirical studies suggest that the euro area economy is characterized by a (i) substantial degree of backward lookingness in output and inflation, (ii) a substantial degree of deficit and interest rate smoothing in the policy rules, government revenues and spending that are strongly dependent on output and fiscal multipliers that are close to but smaller than 1, see e.g. EU (2005) for empirical estimates on budgetary elasticities and Spilimbergo et al. (2009) on fiscal multipliers. In the remainder of the paper we will assume that the monetary and fiscal rules based on the estimates of Table 1 are indeed a not entirely inaccurate representation of policies in the euro area.

Naturally, outcomes may be more or less specific to this set of baseline assumptions. In case of small changes in the parameters, the differences compared to the baseline are typically of a quantitative nature rather than a qualitative nature. If changes get larger, the results can also change qualitatively. Many parameters have been estimated in other papers so that for most parameters there is certainly an amount of empirical plausibility to these values.

I. A government revenue shock

A first interesting example concerns the effects produced in the model by a temporary 1% increase in government revenue, introduced e.g. in the form of a fiscal consolidation effort. Figure 1 gives the adjustment dynamics that result.

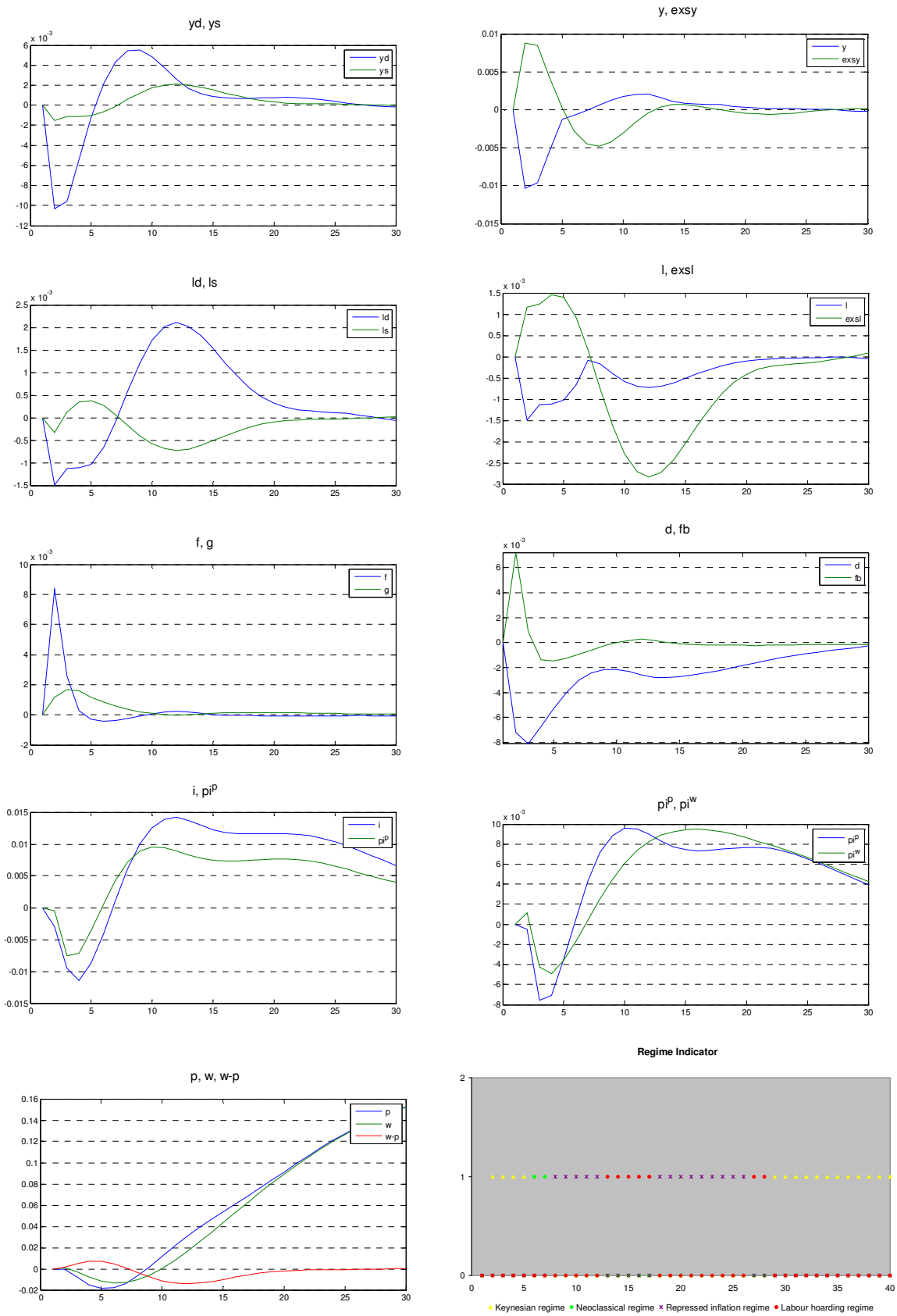


Figure 1 A temporary positive government revenue shock

Increases in taxation do not only improve fiscal balances but alsohave the negative Keynesian type of spending effects and negative labour market effects in the short-run: output and employment decline in the short run.

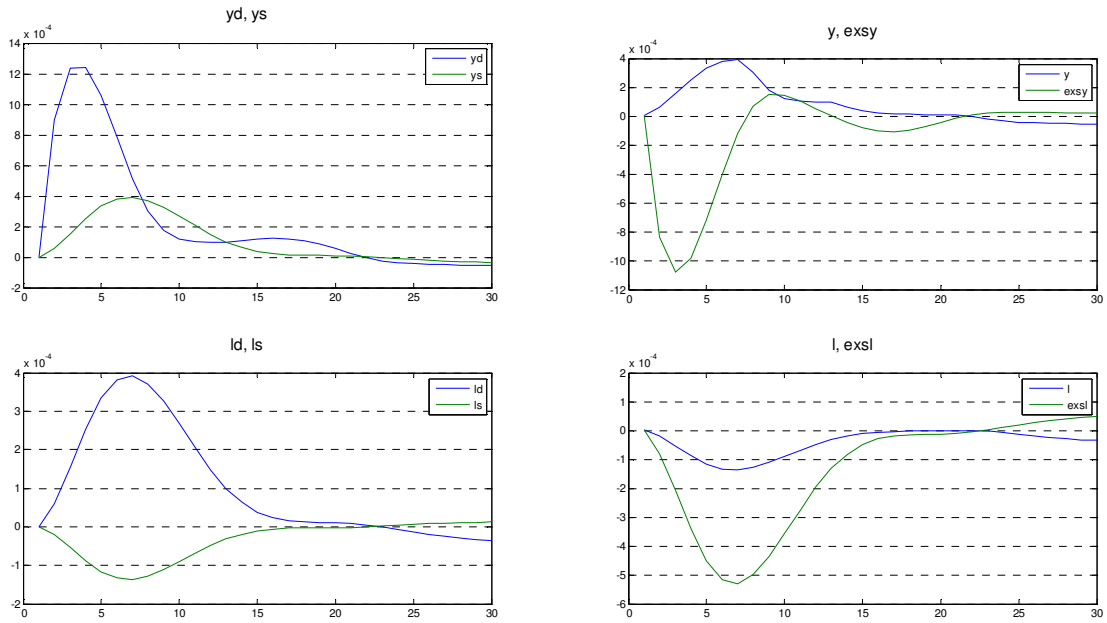
Several regime switches occur: in the short-run a Keynesian regime prevails, but already fairly quick the other regimes manifest themselves also. Regime switches result when the excess labour supply and/or excess goods supply variables change sign. This alternating of regimes produces nonlinearities in the adjustment dynamics: after a regime switch the economy adjusts in a decisively different manner than before the regime switch. The regime switches imply that the economy adjusts fundamentally different than general equilibrium models like a comparable DSGE model.[11] Instead of the smooth, linear adjustment typical of DSGE models, regime switches lead to a non-smooth, "sawed" adjustment behaviour.

Prices and wages start to adjust due to the disequilibria in goods and labour markets. Prices and nominal wages -and therefore- real wages are important drivers of the dynamic adjustments and regime switches. In our parameter setting, prices are somewhat more sensitive to excess supply and taxation than wages, resulting in stronger adjustment and initial real wage increase.

Because of the presence of the different disequilibrium regimes, the model –while continuous- displays non-symmetric, non-linear behaviour as the economy moves from one regime to another. Also, a positive shock is unlikely to display the opposite behaviour of a negative shock of the same size since it is highly unlikely that the economy would only remain in the same disequilibrium regime during the entire adjustment process produced by these shocks. Designing optimal monetary and fiscal policies/policy rules – one of the most thriving research questions addressed in DSGE models- (and any other aspects concerning efficiency) are obviously much harder in the presence of regime switches as the dynamics are essentially non-differentiable at the time of a regime-switch.

II. A monetary policy shock

A second interesting policy innovation is a monetary policy shock. Figure 2 displays the impact of a temporary positive monetary shock (in the form of a negative 1% innovation to the interest rate in period 1):



[11] This is seen in the adjustment dynamics produced in the graphs: while continuous, the model is non-differentiable at regime-switches. This gives the characteristic non-smooth, nonlinear adjustment in the graphs.

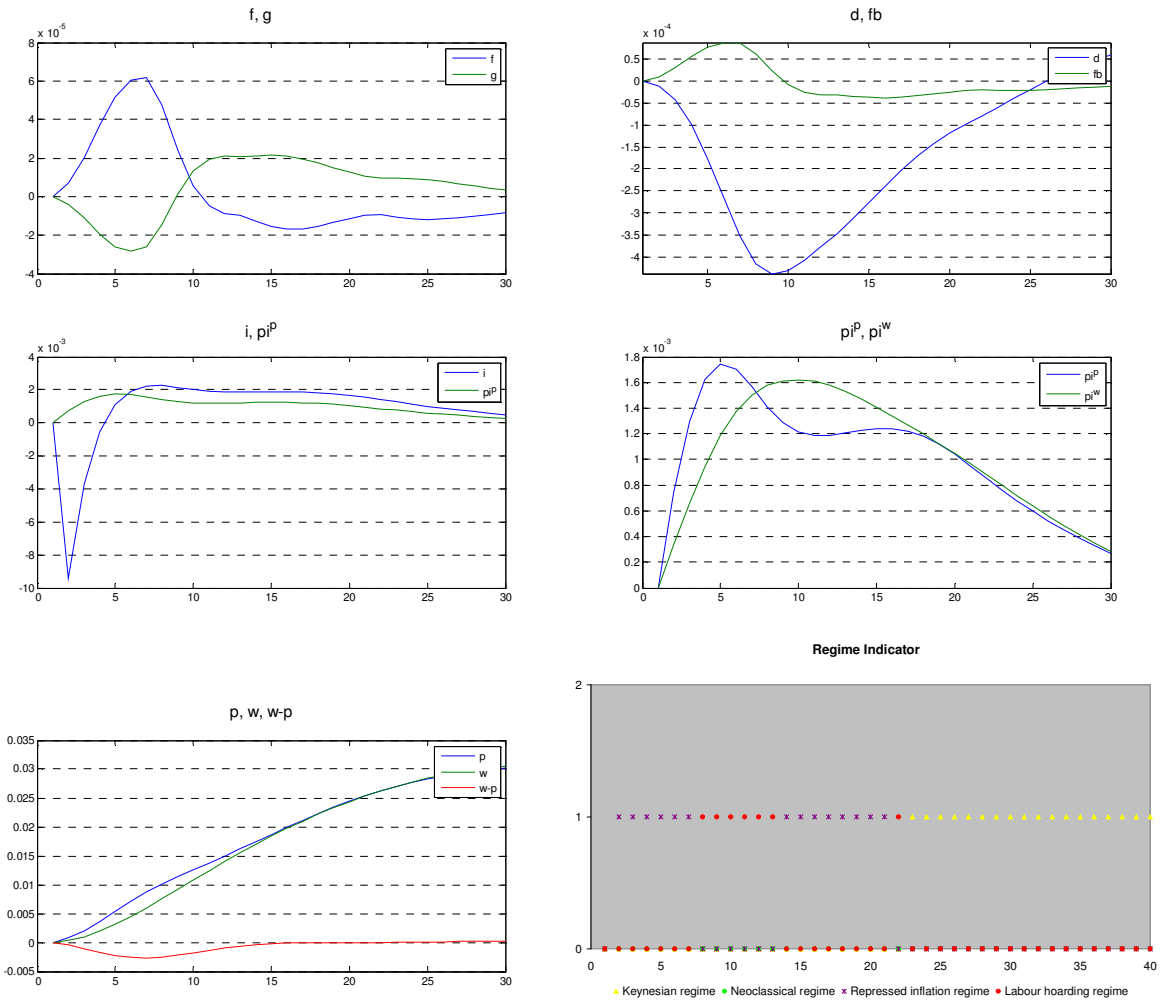


Figure 2 A temporary negative interest rate shock

The economy is stimulated by this monetary impulse, but also price and wage inflation pick up, reflecting the initial Repressed Inflation regime. In the labour market the real wage reduction depresses labour supply and employment declines as labour demand is rationed throughout the adjustment. The Neo-Classical regime is not reached in this expansionary monetary policy regime and the Keynesian regime only towards the end of the simulation when adjustments are largely completed. Note that the reduction of interest rates also has an additional impact on public finances, as it reduces the interest burden and therefore the fiscal balance and debt accumulation.

III. Effects of wage shocks

Wage and price adjustments in reaction to disequilibrium conditions, are at the core of the disequilibrium model. In combination they determine the real wage that is a crucial factor in the adjustment of the labour market. It is therefore interesting to consider the impact of wage and price shocks and trace their effects. In this third example we focus our attention on wage shocks: wage shocks are indeed an important source of macroeconomic shocks and fluctuations in practice. Figure 3 displays the effects of a temporary 1% wage increase.

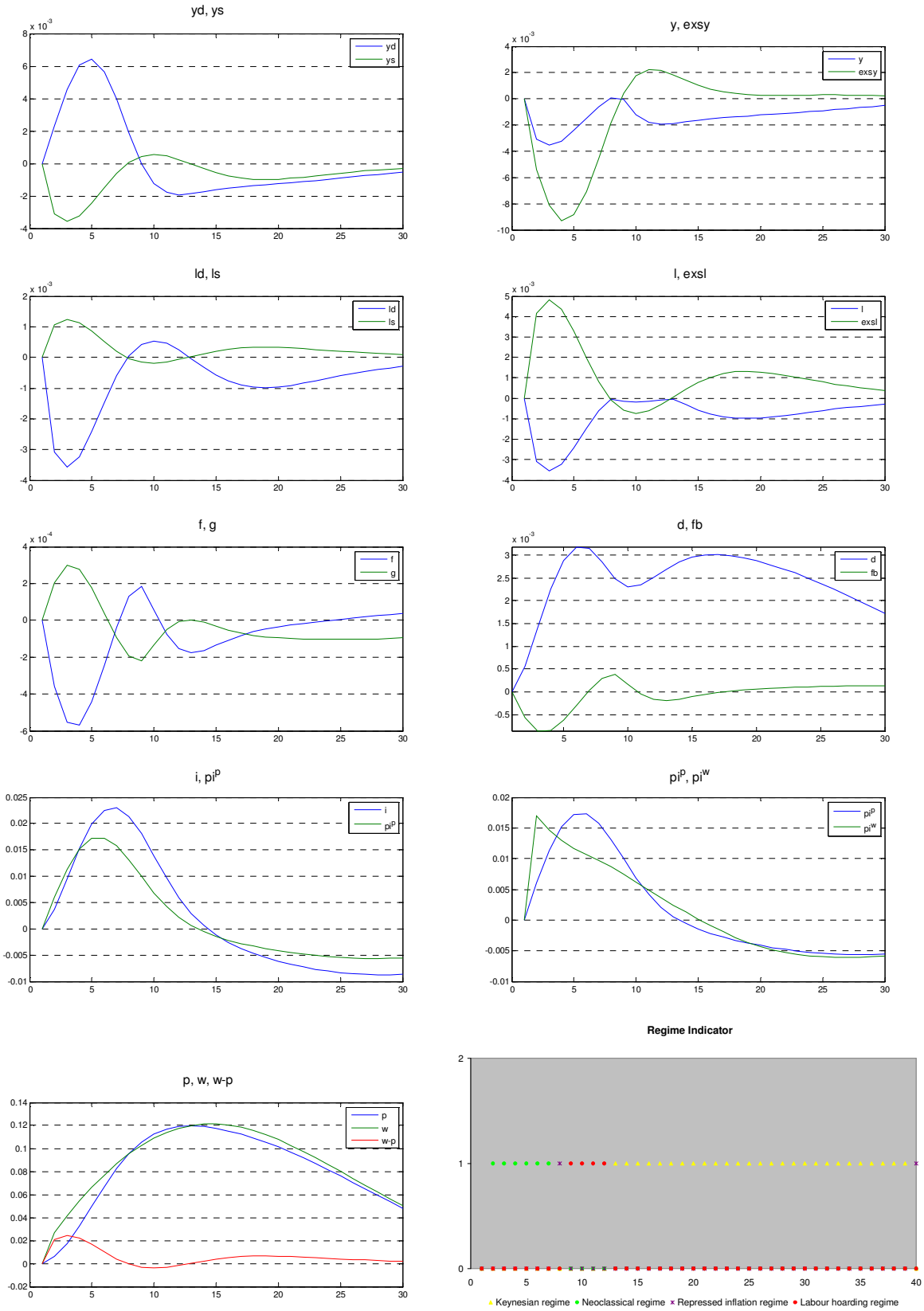


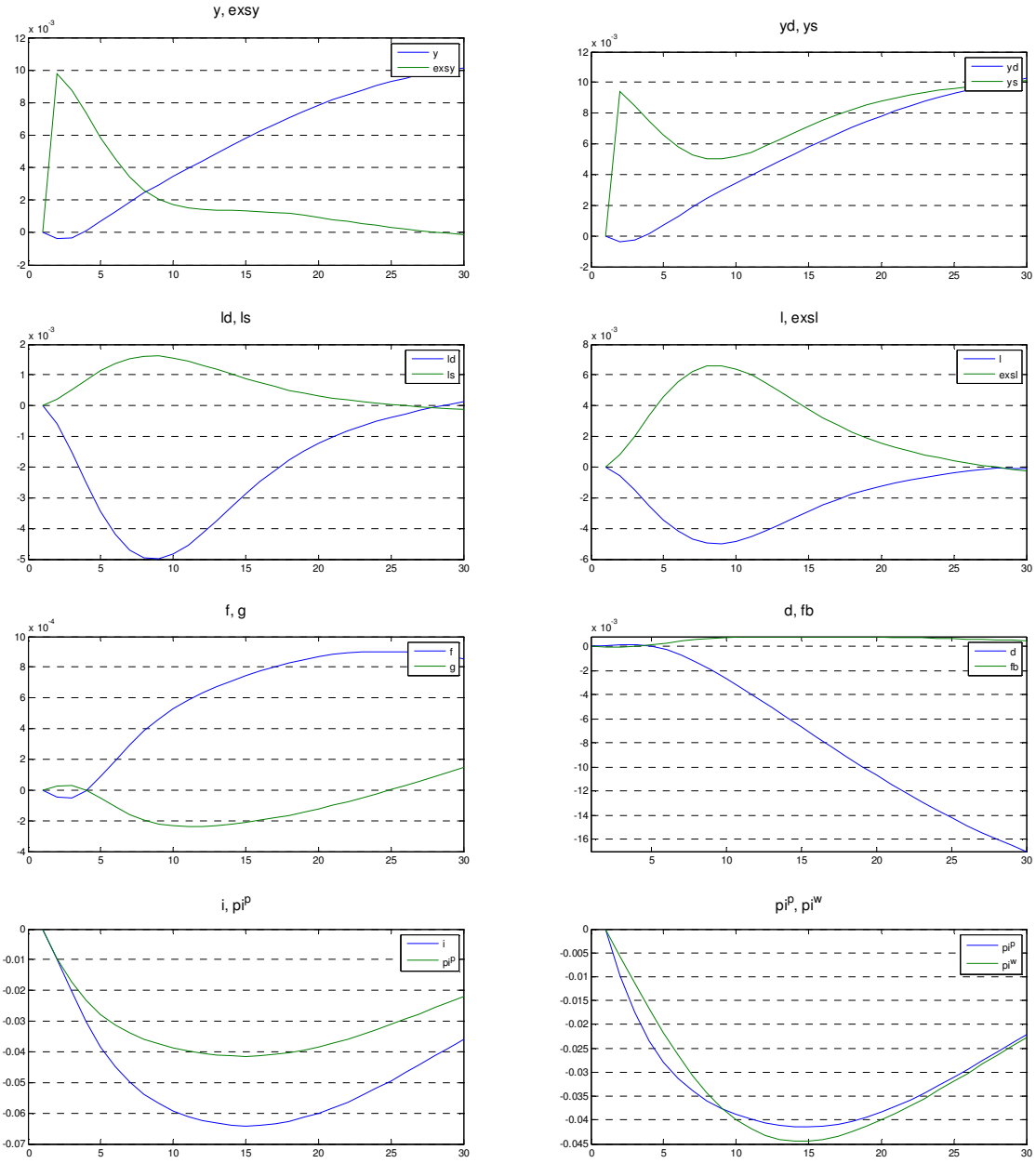
Figure 3 A temporary positive wage shock

The wage shock moves the economy into the Neo-Classical regime where the increase of real wage costs is the source of a depressed labour market. Labour supply is rationed by the lack of demand. This also depresses the goods market where supply declines and rations the increased demand. Interest rates rise

because of inflation and the fiscal balance deteriorates because of the fall in output. Over time the economy moves through the Repressed Inflation to the two regimes with the more Keynesian features, the Labour Hoarding and the true Keynesian Regime. Clearly, the positive wage shock in this setting is not an efficient instrument to stimulate the economy. In fact a form of stagflation is produced in the short-run: higher unemployment and inflation result, compared to the initial equilibrium.

IV. Effects of productivity shocks

Productivity shocks of all sorts are continuously impacting the economy. These shocks, if permanent, have the special feature of lifting output to a permanently higher level, as productivity of workers is permanently higher. In Figure 4, the effects of such a permanent increase in productivity –here by 1%- are displayed:



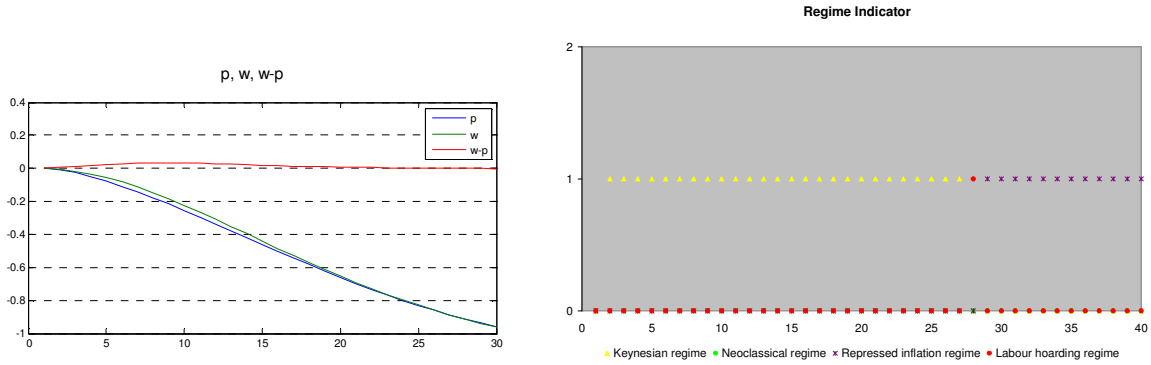
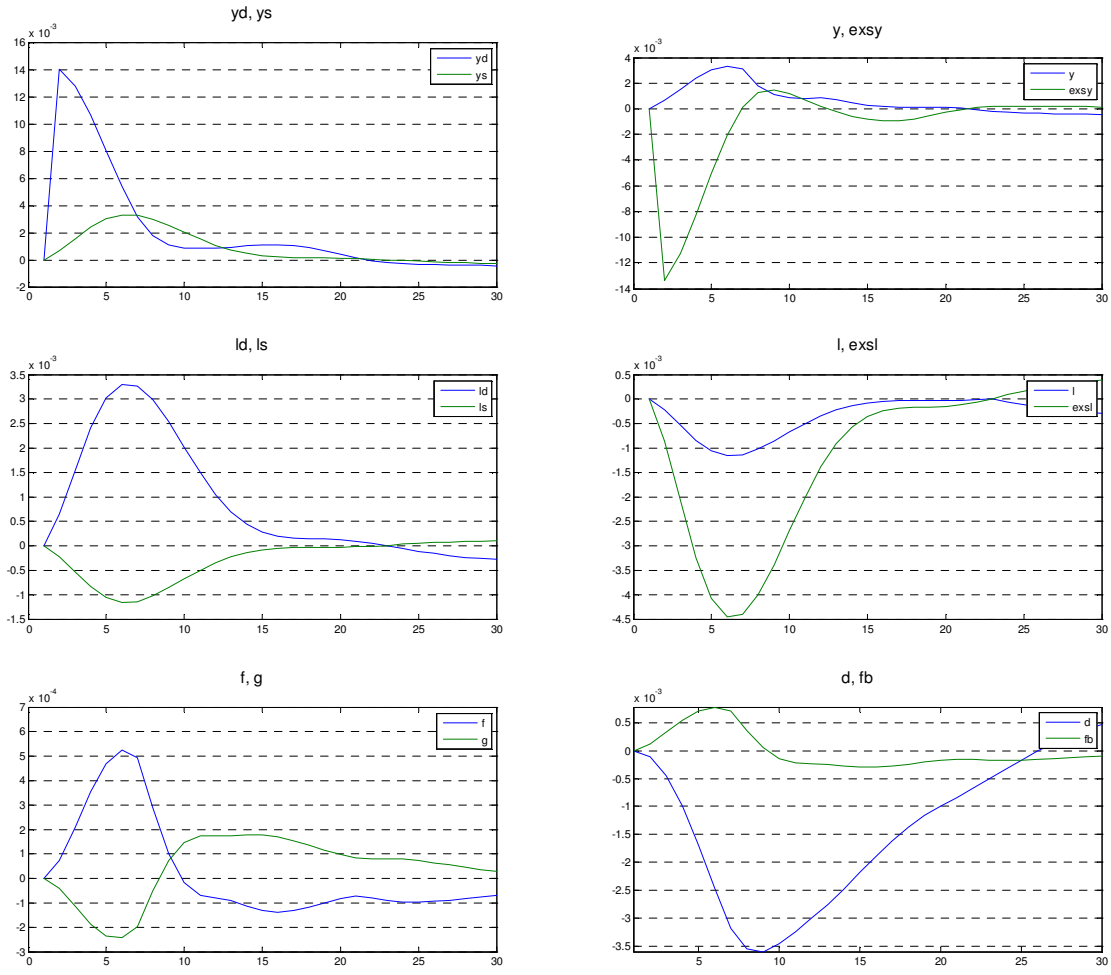


Figure 4 A one percent permanent positive TFP growth shock

The positive productivity shock places the economy firmly in the Keynesian regime as demand trails the increase in supply. Interest rates decline as inflation declines due to the excess supply in the goods market. Prices and wages decline as supply exceeds demand. In this case, the adjustment dynamics are hardly affected by regime switches and seem to resemble more closely the adjustment that would typically result in a comparable DSGE model.

V. Effects of demand shocks

A final source of macroeconomic disturbances that we certainly need to consider are demand disturbances. Figure 5 provides the adjustments produced by a temporary positive 1% demand shock:



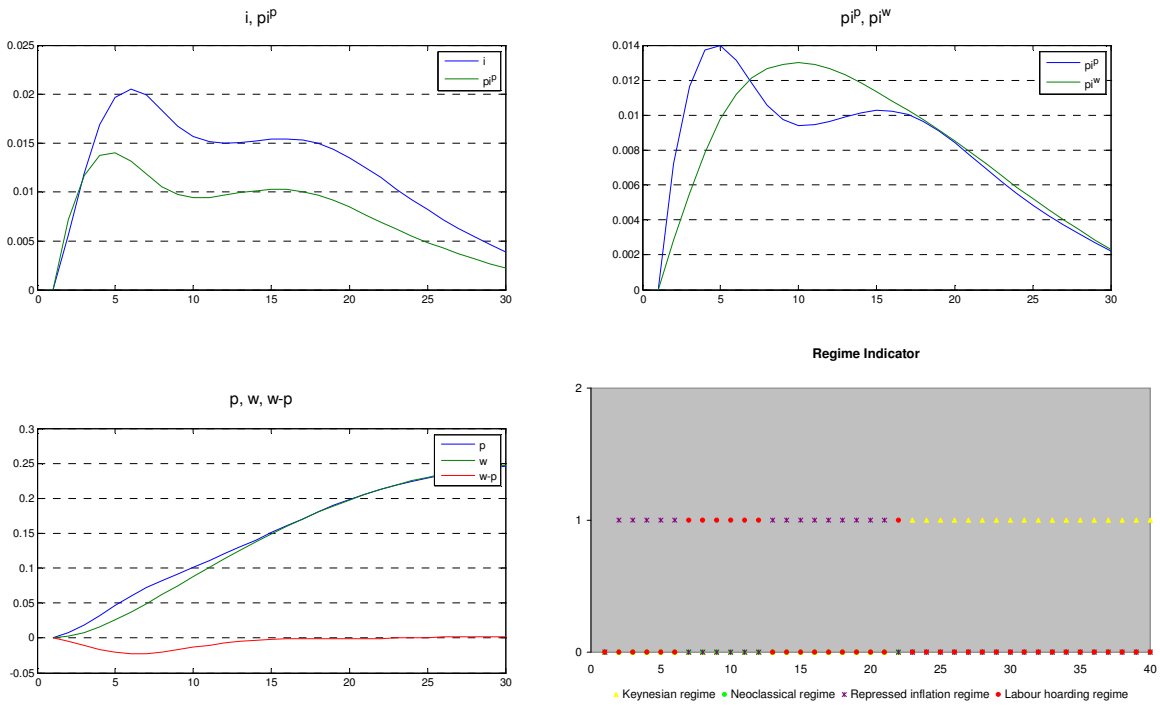


Figure 5 A temporary negative demand shock

Demand shocks only have their full expansionary impact in the Keynesian regime. In the Repressed Inflation regime that dominates the adjustment in the short-run the expansionary impact is limited by supply in the goods market. Nevertheless output expands, improving fiscal balances. Real wages are depressed over time as prices adjust stronger than wages. While far from identical, the adjustment produced by this positive demand shocks bears several similarities with the adjustment produced by the expansionary monetary policy shock in Figure 2.

5. Conclusions

The global financial and economic crisis poses formidable tasks and responsibilities on the shoulders of policymakers. Economists have been blamed for not being able to explain or to have foreseen the impact and unfolding of the macroeconomic shocks and to deliver adequate policy analysis.

Aim of this paper was to contribute to a better understanding of macroeconomic fluctuations and possibly to the dynamics of the economic and financial crisis: our contribution focused on the integration of disequilibrium analysis into a stylized DSGE model. A major weakness or limitation of the DSGE models lies possibly exactly in their excluding of disequilibrium/rationing in goods and labour markets. Disequilibrium models on their turn focus exactly on such disequilibria and consider the possibility of regime switches explicitly.

Disequilibrium analysis complicates considerably the dynamics and analysis compared to the standard DSGE model. The presence of different disequilibrium regimes implies that the dynamics of the model are dependent on the disequilibrium regime. This impacts e.g. on the transmission of shocks and the effects of macroeconomic policies. Our examples of fiscal and monetary policy innovations, wage, productivity and demand shocks found that regime switches occur easily and frequently.

Relating back to the economic and financial crisis, our results hint at the possibility that considering regime switches may be helpful for a better understanding of the complex adjustments produced by the global financial crisis. It seems unlikely that the shocks and their transmissions produced by the global

financial crisis can only be understood from either a Keynesian or Neo-Classical perspective and in fact may have produced a series of regime switches.

Much work would remain to be done to work an in-depth analysis of the financial and economic crisis with the model: a full empirical estimation would be required and simulations of multiple shocks and policy scenarios be worked out to take more into account the complexity of it. A robustness analysis would also need to be considered as it is very unclear how robust the complex dynamics produced by the regime switches are with respect to small parameter changes. Designing optimal monetary and fiscal policy (rules) would be another formidable challenge for the model. While it appears feasible in principle to design also here optimal policies, the possibility of regime switches of course complicates greatly the tasks for monetary and fiscal policymakers when designing and implementing their strategies. The complexity introduced by regime switches seems to increase even more the need to avoid policy errors since largely unintended effects may be produced. In that respect the unorthodox policy measures implemented to combat the global economic and financial –like the quantitative easing policy in the US and fiscal austerity in Europe- crisis need to remain subject of close scrutiny as this margin to commit policy errors without substantive consequences, appears very small.

References

Arcand, J. and E. Brezis (1993), Disequilibrium dynamics during the Great Depression, Journal of Macroeconomics, vol.15(3), p.553-589.

Benassy, J. (1975), Neo-Keynesian disequilibrium theory in a monetary economy, Review of Economics and Statistics, vol. 42, p.503-523.

Barro, R., and Grossman, H., (1971), A general disequilibrium model of income and employment, American Economic Review vol.61, p.82-93.

Clarida, R. J. Gali, and M. Gertler (1999), The science of monetary policy: a New-Keynesian perspective, Journal of Economic Literature, vol.37, p.1661-1707.

Coenen, G., M. Mohr, and G. Straub (2008), Fiscal consolidation in the euro area: Long-run benefits and short-run costs, Economic Modelling, vol.25, p.912-932.

De Grauwe, P. (2009), DSGE-modelling when agents are imperfectly informed, ECB Working Paper Series No. 897.

Dieppe, A. and J. Henry, (2004), The euro area viewed as a single economy: how does it respond to shocks?, Economic Modelling, 21(5), 833-875.

Erceg, C., D. Henderson and A. Levin (2000), Optimal monetary policy with staggered wage and price contracts, Journal of Monetary Economics, vol.46, p.281-313.

European Commission (2005), New and updated budgetary sensitivities for the EU budgetary surveillance. European Commission Directorate General Economic and Financial Affairs.

German, I. (1982), Disequilibrium dynamics and the stability of quasi equilibria, Quarterly Journal of Economics, vol.100(3), p.571-596.

Grossman, H. (1971), Money, interest and prices in market disequilibrium, Journal of Political Economy, vol.79(5), p.954-961.

Grossman, H. (1973), Aggregate demand, job search, and employment, Journal of Political Economy, vol.81(6), p.1353-1369.

Malinvaud, E. (1982), Macroeconomic theory. Volume B: Economic growth and short-term equilibrium, Elsevier Advanced textbooks in economics, volume 35.

Milani, F. (2009), Adaptive Learning and Macroeconomic Inertia in the Euro Area, Journal of Common Market Studies, vol. 47(3), p. 579-599.

Picard, P. (1993), Wages and unemployment. A study in non-Walrasian macroeconomics. Cambridge University Press, ISBN 0521350573.
Svensson, L. (2000), Open-economy inflation targeting, Journal of International Economics 50 (2000) 155–183.
Sbordone, A., A. Tambalotti, K. Rao, and K. Walsh (2010), Policy analysis using DSGE models: An introduction, Federal Reserve Bank of New York Economic Policy Review October 2010.
Smets, F., and R. Wouters (2003), An estimated stochastic dynamic general equilibrium model of the Euro Area, Journal of the European Economic Association, vol.1, p.1123–1175.
Soederstroem, U., P. Soederlind and A. Vredin (2005), New-Keynesian models and monetary policy: A re-examination of the stylized facts, Scandinavian Journal of Economics 107(3), p.521–546.
Spilimbergo, A., S. Symansky and M. Schindler (2009), Fiscal multipliers, IMF Staff Position Note SPN/09/11.
Woodford, M. (2003), Interest and prices: Foundations of a theory of monetary policy. Princeton University Press, ISBN 0691010498.