Comment on
"The Output Composition Puzzle: A difference in the monetary transmission mechanism in the euro area and U.S."

by

Angeloni, Mojon, Kashyap and Terlizzese

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On January 1 1999, twelve European countries tied their exchange rates, and the European monetary union - the largest currency area in the world was in effect. At the same time, the politicians gave the European Central Bank (ECB) the task of keeping the inflation rate within the interval $0-2$ percent. The key questions for the ECB are: if, how, and to what extent does monetary policy affect quantities and prices in the euro area? There are at least two ways that the ECB could tackle this very complicated issue. For an economist, an obvious route would be to write down a theoretical model with a role for money and examine how monetary policy affects the economy. A serious problem with this approach is that different, *a priori* equally plausible, theoretical models have very different implications regarding the dynamic effects of monetary policy.

An alternative approach is to make use of the large empirical literature on the effects of monetary policy for the U.S. economy, and construct a synthetic data sample for the euro area, and examine to what extent the synthetic euro data produce roughly the same picture as for the U.S. economy. If differences arise in some dimensions, then one could try to use theoretical models along with knowledge about existing differences in the economic environment in the U.S. and euro area in order to (hopefully) be able to come with convincing explanations for the differences. A natural step in this analysis would also be to analyze the effects of monetary policy in the individual euro area memberships countries, and cross-check that the synthetic aggregate data gives about the same picture as when aggregating the results for the individual membership countries.

The second approach described above is adopted by Angeloni, Kashyap, Mojon, and Terlizzese (henceforth AKMT) in their paper. Using synthetic quarterly data for the euro area (1970 – 2000) and U.S. data (1960 – 2001) they examine the dynamic effects of monetary policy by means of vector autoregressions (VARs) and large-scale structural models. Their finding is that in most respects, the results on euro data are very similar to the ones obtained for the U.S. economy. For instance, the effects of monetary policy on output, consumption, investment, and inflation in the euro area display a "hump-shaped" pattern with peak effects after about two years, completely in line with the "consensus view" for the U.S. However, AKMT argue that one feature of the monetary transmission mechanism differs substantially; in the U.S. consumption spending appears to be the most important component whereas in the euro area consumption does not appear to respond as much to monetary policy. Instead, the response of investment seems to be the main driver behind private sector domestic demand (PSDD) in the euro area according to AKMT. AKMT dub this difference the "output composition puzzle" and provide tentative interpretations and explanations for it in two ways. Firstly, they use the most recent generation of dynamic stochastic general equilibrium (DSGE-) models that have proven to be able to replicate the dynamic effects of a shock to monetary policy in the data (see e.g. Christiano, Eichenbaum and Evans, 2001 - henceforth CEE). They argue that this generation of DSGE-models is not able to account for the different response in the U.S. and the euro area regarding the composition of the PSDD response. Secondly, AKMT adopt a simple life cycle approach in order to assess to what extent the obtained differences in consumer behavior can be attributed to different characteristics of the financial structures, the functioning of the labor markets, and government insurance systems in the U.S. and euro area. AKMT find the government insurance mechanism most promising, but the evidence is only indicative, and they therefore emphasize that further research is warranted to examine these latter explanations more thoroughly.

An obvious drawback with the approach adopted in the paper is that the use of the synthetic euro data is susceptible to the Lucas (1976) critique for policy evaluation, a problem which is recognized by the authors themselves in the paper. But by providing some confirming evidence for the individual countries that account for about 80 percent of the euro area, and citing more comprehensive work by Mojon and Peersman (2003) which shows similar patterns when using individual membership country data prior to the adoption of the common currency, AKMT argue convincingly against their results for the euro area being accidental.[1] Moreover, in my view the results reported by AKMT for the euro area gain credibility because AKMT are able to present some reasonable economic arguments that are promising candidates to explain the obtained differences. Another notorious potential drawback in the analysis is how the policy shock is identified. The results reported by AKMT could reflect inherent problems with the identifying assumptions rather than similarities/differences in the euro area and U.S. But since AKMT show that different empirical models give rise to roughly the same picture, I think they argue convincingly against this critique as well.

In the rest of my discussion, I want to make two points. The first being that I think that there is an additional difference in the output composition between the euro area and the U.S. that AKMT do not discuss in their paper. My second point is that I am not convinced by the arguments in the paper that the most recent class of DSGE-models cannot account for the observed differences in the composition of PSDD between the euro area and the U.S. Finally, I will make some concluding remarks.

An additional feature of the output-composition puzzle?

AKMT point out the output composition puzzle in the response of something they call private sector domestic demand (PSDD), i.e. consumption plus investment. Here we are going to broaden

[1] Dedola and Lippi (2002), however, report some evidence which suggests that the monetary transmission mechanism may differ between important countries in the Euro area. Using monthly data between 1975 – 1997, they find; (i) using aggregate monthly data that industrial production and prices in Germany respond more strongly to an equally sized policy shock than in France, Italy, and the U.K., and (ii) using industry level data they document significant cross-industry heterogeneity effects. Thus, if the industry structure between Euro area countries differs, there are reasons to believe that the monetary transmission mechanism might be different.

the perspective by also considering the response of the "rest of GDP", i.e. $Y_t - C_t - I_t$. In order to study these effects, I estimate a version of the CEE (2001) VAR model $X_t = B(L) X_{t-1} + u_t$.[2] For the U.S., the following variables are included in X_t (all lower case variables are in logs)

$$[\ c_t \quad i_t \quad \log(Y - C - I)_t \quad \pi_t \quad w_t \quad y_t - l_t \quad R_t \quad sp_t \quad prof_t \quad \mu_t\ ]',$$

where c_t is consumption, i_t investment, Y_t GDP, π_t annualized quarterly inflation rate, w_t the real wage, $y_t - l_t$ labor productivity, R_t the Fed Funds rate, sp_t real stock prices, $prof_t$ real profits, μ_t money growth in M2. In the VAR model for the euro area, I drop sp_t and include the real exchange rate q_t instead, and condition on the exogenous variables inflation in U.S. commodity prices, U.S. GDP, and the Fed Funds rate as AKMT do. In both VAR models, I include a linear trend and use 4 lags in the estimations. The sample period is $1960Q1 - 2001Q4$ for the U.S. and $1970Q1 - 2000Q4$ for the euro area. Because it is not possible to distinguish between consumption of durable and non-durable goods in euro area data, AKMT choose to include consumption of durables in c_t rather than in i_t also for the U.S. in order to render the results greater comparability. Since current theoretical model suggest that durables should be included in i_t rather than c_t I will report results for the U.S. when durables are included in i_t as well.

In Figure 1, the solid line shows the impulse response functions (grey area indicates 95 percent MLE asymptotic confidence intervals) to a policy shock in the U.S. and the euro area to a policy shock identified the same way as in AKMT (see AKMT for details). The dashed line for the U.S. is for the model with durables included in i_t rather than in c_t.[3]

[2] I would like to thank AKMT for kindly providing me with their data which made this experiment possible. See their data appendix for exact definition of variables.

[3] For the Euro area, i_t is measured as private investments rather than total investments. But as emphasized by AKMT, using total investments instead gives very similar results.

Figure 1: Impulse response functions for selected variables to a monetary policy shock in the U.S. and the Euro area.

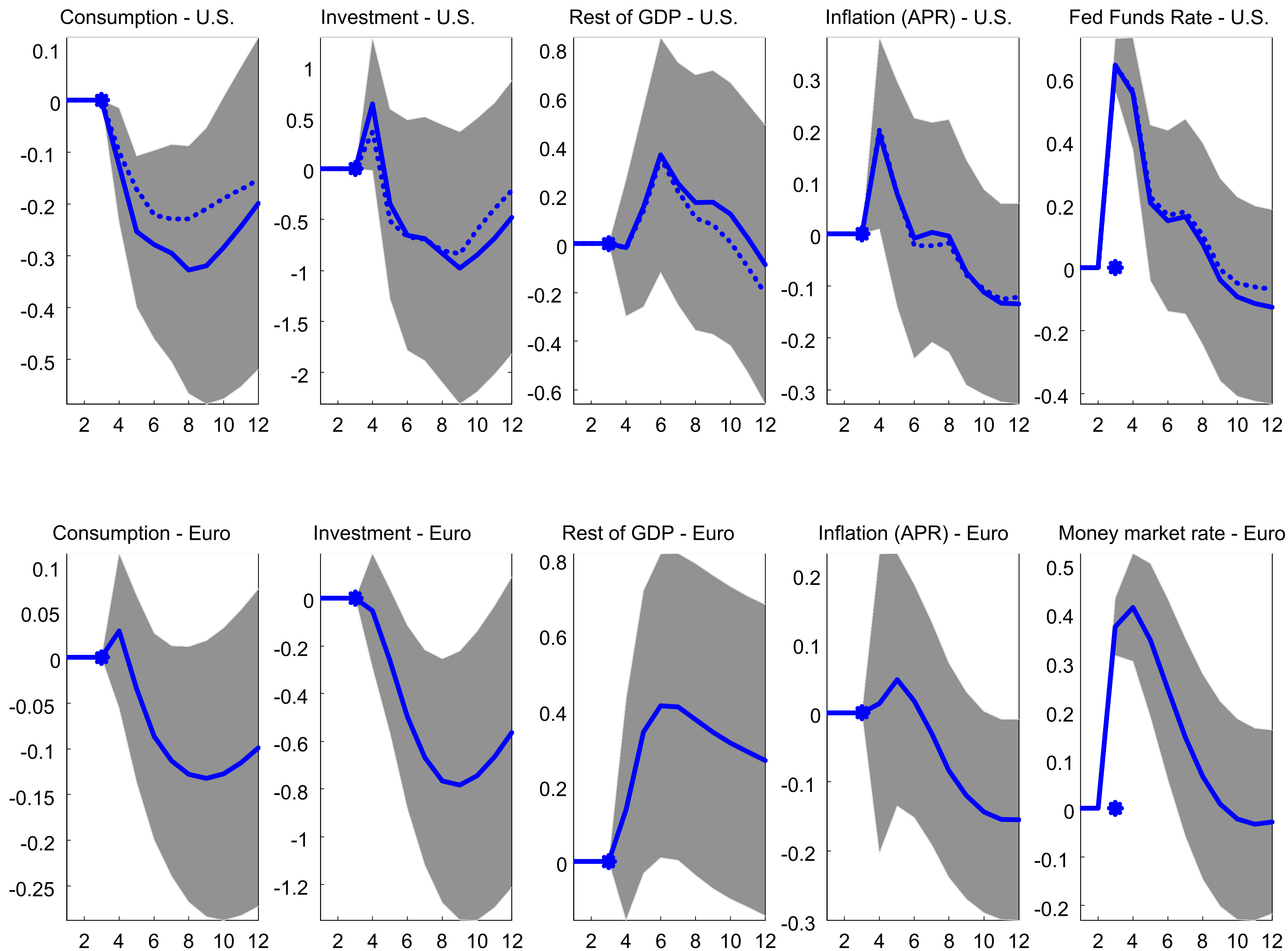


Figure 1 reveals an interesting difference between the U.S. and the euro area, $\log(Y-C-I)_t$ responds much less in the U.S. So the results in Figure 1 suggest another potentially important difference in the transmission mechanism of a policy shock. Other aspects are remarkably similar, except that consumption seems to move less in the euro area as emphasized by AKMT. However, we note that the treatment of durable goods is of importance for how clearly the output composition puzzle emerges. In Table 1, I report the cumulated variance of GDP for different horizons that can be attributed to the GDP components investigated along with 90 percent bootstrapped confidence intervals. The table confirms the picture in Figure 1. For the U.S., we cannot reject the hypothesis that the contribution from rest of GDP is essentially zero, whereas for the euro area this component appears to be very important.

Table 1: Cumulated variance of GDP on different horizons h attributed to different components following a shock to monetary policy in the VARs.

	euro area			**U.S.**					
hori-				Durables in I			Durables in C		
zon h	C	I	$Y-C-I$	C	I	$Y-C-I$	C	I	$Y-C-I$
4	.19	.41	.40	.44	.41	.15	.66	.18	.16
	(.04–.33)	(.26–.59)	(.18–.64)	(.27–.68)	(.14–.59)	(.02–.32)	(.42–.85)	(.04–.40)	(.02–.32)
8	.24	0.46	.30	.42	.50	.08	.59	.31	.10
	(.07–0.37)	(.37–.61)	(.13–.47)	(.27–.63)	(.23–.63)	(.01–.27)	(.39–.80)	(.10–.46)	(.01–.26)
12	.25	.46	.29	.52	.46	.02	.66	.30	.04
	(.05–.41)	(.36–.61)	(.13–.47)	(.29–.68)	(.08–.60)	(.01–.35)	(.38–.81)	(.05–.46)	(.01–.29)

Notes: 90-percent confidence intervals in parentheses are given by the 5^{th} and 95^{th} percentiles of the empirical distributions resulting from $1,000$ Monte Carlo simulations with the estimated VAR's. Let $\mathrm{IRF}_{x,t+s}$ denote the impulse response of variable x to a policy shock $\varepsilon_{P,t}$ in period $t+s$. The response of output to a policy shock can be computed as $\mathrm{IRF}_{y,t+s}=\frac{C}{Y}\mathrm{IRF}_{c,t+s}+\frac{I}{Y}\mathrm{IRF}_{i,t+s}+\left(1-\frac{C}{Y}-\frac{I}{Y}\right)\mathrm{IRF}_{yr,t+s}$ for $s=1,2,...,h$ and where $\frac{C}{Y}$ and $\frac{I}{Y}$ are the average consumption-/investment-output ratios in the data. Note that $\mathrm{IRF}_{y,t}=0$ as a consequence of the adopted identification scheme in the VAR and DSGE model. Let $\mathrm{c}_{x,h}=\frac{X}{Y}\sum_{s=1}^{h}\mathrm{IRF}_{x,t+s}/\sum_{s=1}^{h}\mathrm{IRF}_{y,t+s}$, then the cumulated fraction of the variance in GDP due to variable x after a policy shock for horizon h, $\mathrm{cv}_{x,h}$, can be computed as $\mathrm{abs}(\mathrm{c}_{x,h})\,/\,(\mathrm{abs}\,(\mathrm{c}_{c,h})+\mathrm{abs}\,(\mathrm{c}_{i,h})+\mathrm{abs}\,(\mathrm{c}_{yr,h}))$. Note that $\mathrm{cv}_{x,h}$ is bounded between 0 and 1.

Because the "rest of GDP" consists of government consumption (G_t) and net export (NX_t), the positive and persistent response of to an exogenous increase in the money market rate for the euro area must be due to either G_t or NX_t going up. Further analyses are warranted in order to examine which of the components is the key driver behind this response, but if the real exchange appreciates after an unexpected tightening of policy, this normally implies a drop in NX_t, which suggests an increase in G_t rather than NX_t. An interesting implication of these findings for model builders is that for the U.S., models with only consumption and investment seem to be a reasonable approximation, whereas for the euro area models where $Y=C+I$ holds appear to be a more unrealistic short-cut.

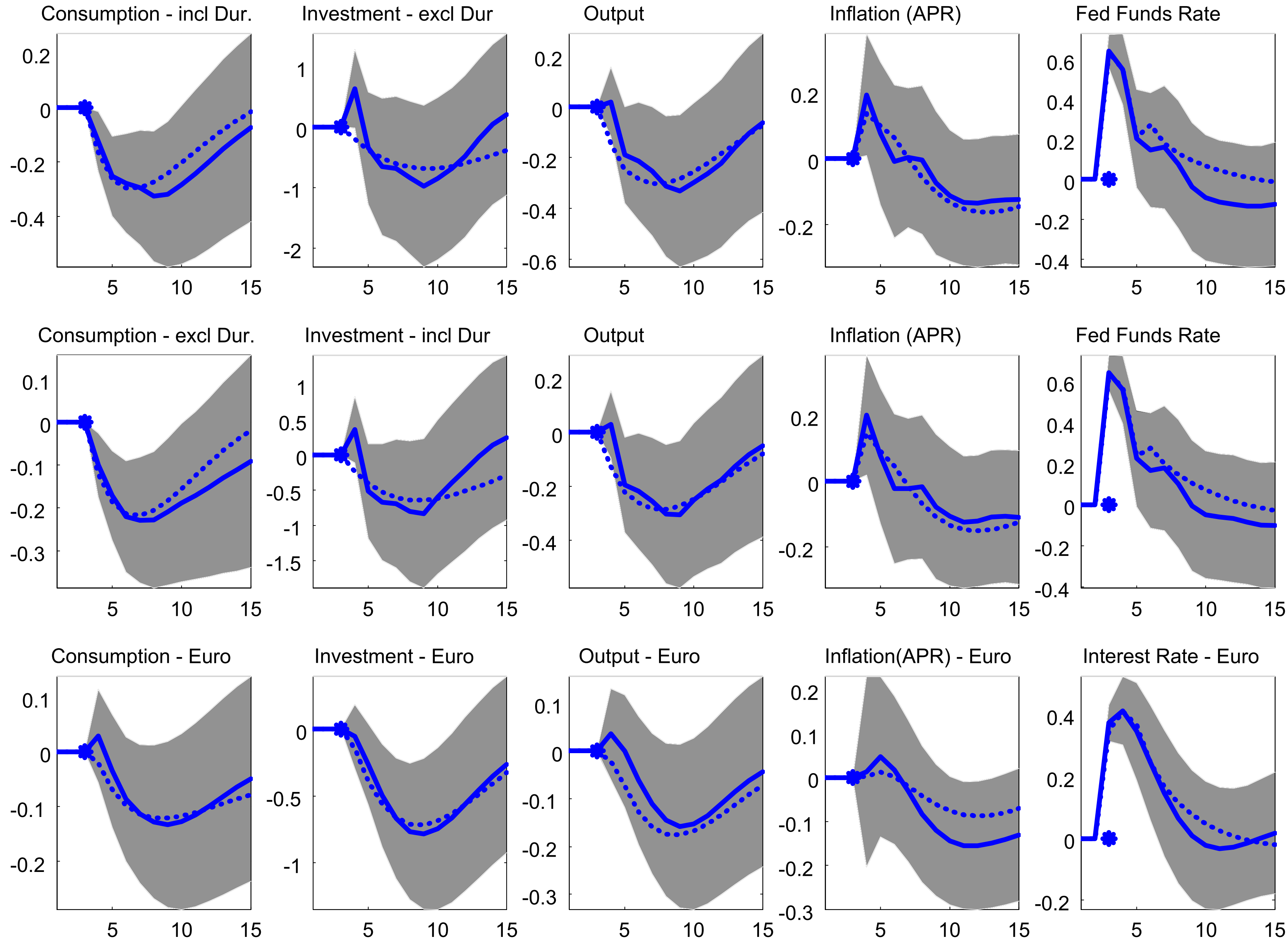
Can DGSE-models replicate the output composition?

If we set aside the response of the rest of GDP to a policy shock, AKMT argues by that the most recent version of DSGE-models of the euro area and the U.S. economy have a hard time in replicating the output composition of PSDD after a policy shock. The investment share of fluctuations in PSDD after a policy shock appears too big in the model compared with the data for "reasonable" parameter values. In this section we are going to study this issue in greater detail by using the CEE (2001) model augmented with government expenditures (for reasons discussed above). Throughout the analysis, I will maintain the assumptions that G_t enters additively in the utility function and that it is financed with lump-sum taxes in the model, which implies that only the aggregate resource constraint is affected and not the first-order conditions. The strategy when estimating the theoretical model is the same as the one employed in CEE (2001), i.e. the values of the deep parameters in the model are chosen so that the impulse response functions in the model to a policy shock resembles those estimated in the VARs in the previous section as closely as possible subject to the uncertainty.[4] It is important to notice that the identification assumptions that are used in the VAR are fulfilled in the theoretical model as well. In addition to estimating some deep parameters in the model, I also jointly estimate the parameters describing monetary policy and how government expenditures (G_t) respond to a monetary policy shock.[5] However, I will not report the estimation results for the policy parameters, since what is interesting to compare are the estimation results for the deep parameters. As in CEE (2001), I use 20 quarters after the policy shock has occurred to match the impulse response functions in the model and the data.

[4]Note that there is a subset of deep parameters that are calibrated and hence not estimated.

[5]For the response of money growth following policy shock, I use an ARMA(1,1)-process $\mu_t = \rho_\mu \mu_{t-1} + \varepsilon_t + \phi\varepsilon_{t-1}$, and for the response of G_t to a policy shock ε_t I use the process $G_t = \rho_G G_{t-1} + \sigma_{G\mu,1}\varepsilon_{t-1} + \sigma_{G\mu,2}\varepsilon_{t-2} + \sigma_{G\mu,3}\varepsilon_{t-3}$. Note the one-period lag of ε in the G_t process because of the adopted "recursiveness assumption" in the VAR (a monetary policy shock has zero effect on output in period t). I also include ε_{t-1} and ε_{t-2} because the impulse response for $\log(Y - C - I)_t$ in the VAR peaks after 2-3 periods. So 7 policy parameters (ρ_μ, ϕ, σ_ε, ρ_G, $\sigma_{G\mu,1}$, $\sigma_{G\mu,2}$, and $\sigma_{G\mu,3}$) are included in the estimation in addition to the deep parameters. Finally, the deep parameters in the model that are not estimated are set to the same values as in CEE (2001) except δ (the depreciation rate) which is set so the the ratios $\frac{G}{Y}$, $\frac{C}{Y}$, and $\frac{I}{Y}$ in the model equal the sample averages in the data. For the U.S. with durables in C, I compute $\frac{G}{Y} = .196$, $\frac{C}{Y} = .640$, $\frac{I}{Y} = .164$, and $\delta = .009$. When durables are included in I, I used $\delta = .021$ instead (to match $\frac{C}{Y} = .560$ and $\frac{I}{Y} = .254$).

Figure 2: Data and Model impulse response functions to a policy shock in the U.S. and the Euro area



This strategy implies that if the impulse response functions in the data and the model during the first 12 quarters (which is the horizon AKMT use to measure how different components contribute to the fluctuations in PSDD) line up well for i_t and c_t, then the output composition in the model resembles the one in the data. In Figure 2, the dashed lines show the impulse response functions in the model using the estimated deep parameters along with the ones estimated in the VAR (solid lines). Since the fit of the model is very good, we can conclude that the model is very successful in replicating the PSDD composition to a policy shock. The estimated deep parameters which enable the model to do so are reported in Table 2, along with the CEE (2001) estimates.

Table 2: Estimated parameters when fitting CEE (2001) model to U.S. and euro data for a shock to monetary policy.

Parameter	**CEE (2001) - U.S.**	**euro area**	**U.S.** Durables in I	**U.S.** Durables in C
ξ_w	0.70 (.07)	0.60	0.77	0.75
ξ_p	0.50 (.23)	0.71	0.42	0.44
λ_f	1.46 (.16)	1.50	1.26	1.15
σ_q	9.66 (.78)	7.95	14.29	13.61
S''	3.60 (2.24)	3.19	7.28	9.96
b	0.63 (.07)	0.78	0.68	0.58
σ_a	0.01 (–)	0.13	0.19	0.02

Notes: ξ_w is the probability that a household cannot reoptimize the wage, ξ_p is the probability that the monopoly supplier of the intermediate goods cannot reoptimize its price, λ_f is the markup set by monopolist intermediate goods suppliers, σ_q is a curvature parameter related to money demand, S'' is a curvature parameter related to adjustment costs of investment, b is the habit parameter, and σ_a is the parameter controlling the curvature on costs of capital utilization. Parameters for the response of monetary policy and government expenditures to a policy shock were also included in the estimation. The σ_a parameter in CEE (2001) model was fixed at 0.01 as a lower bound.

Since AKMT argue that the parameters determining the composition of PSDD - which is the focus here - are S'' (adjustment costs of investment, higher value implies higher costs), b (habit parameter, higher value implies higher degree of habit), and σ_a (costs of varying capital utilization, higher value implies higher costs of changing the utilization rate). From Table 2, we see that the estimates of these parameters for the euro area and the U.S. also display some differences. In particular, the estimated degree of habit and costs of varying capacity utilization appear to be higher for euro area, while the costs of adjusting investment are about the same. AKMT argue that these differences are implausible, but I think that further analyses are warranted before one can draw such a conclusion. For instance, given the situation on the European labor markets, it is not surprising to me that the costs of varying the capacity utilization rate are higher in the euro area than in the U.S. Moreover, fixing S'', b, and σ_a at the U.S. estimates and only reoptimizing w.r.t. to the other parameters does not deteriorate the fit of the model substantially and hence not the PSDD composition as well. However, I share some of the concerns expressed by AKMT regarding the interpretation of the differences in the estimates, since the theoretical foundations underlying these frictions in the model are not strong. Finally, AKMT admittedly have a point when they say that the differences in parameters needed when trying to match more shocks with the model than just the policy shock might potentially give rise to implausible parameter differences. However, Altig et al. (2002) incorporate unit-root technology shocks in the CEE (2001) model which account for a substantial part of U.S. macroeconomic fluctuations, and shows that monetary policy shocks are still very useful in unraveling the structure of the model economy, so it not clear that bringing in more shocks in the analysis would alter the findings above.

Concluding remarks

In my view, AKMT have written a very interesting paper. Based on the empirical findings and the economic arguments in the paper, I think the authors argue convincingly that there is a case for the view that the monetary transmission mechanism in the euro area might be different than in the U.S. However, for reasons discussed above I do not agree at this stage with the view advocated by AKMT that the recent generation of DSGE-models cannot account for the output composition. Nevertheless, I find their alternative interpretations and exploration of underlying mechanisms in the paper interesting and worthwhile pursuing. I also argued in my discussion that there might be an additional important difference in the output composition after a monetary policy shock, because the rest of GDP appears to move a lot more in the euro area than in the U.S. after a shock to monetary policy. An interesting implication of this finding is that model builders of the euro area model should include a mechanism that captures in the response of $\log{(Y - C - I)_t}$ properly (i.e. work with an open economy model or include government expenditures). When building models for the U.S. economy, models with only private consumption and investment appear sufficient.

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