



ECONOMIC POLICY NOTE 13/2/2017

It's the WACC, stupid!

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- Central banks have made strong efforts to lift investment spending of companies by depressing interest rates. However, investment has not responded as expected.
- In this paper we show that it is the weighted average costs of capital (WACC) rather than interest rates on debt capital that have a significant influence on investment. But WACC have not moved down in tandem with interest rates, supporting the theorem of the constant cost of capital.
- Hence, both theory and empirical analysis suggest that the low interest rate policy of central banks has been ineffective in raising investment.

In the wake of the Great Financial Crisis central banks have tried to revive the economy through low interest rates. Their intention was to stimulate lending for investment purposes so as to revive growth and lift inflation to their targets. To bring interest rates down, central banks have cut their policy rates and massively bought securities. The purchase of securities was most likely helpful in bringing down interest rates in the credit market.¹ This is illustrated in

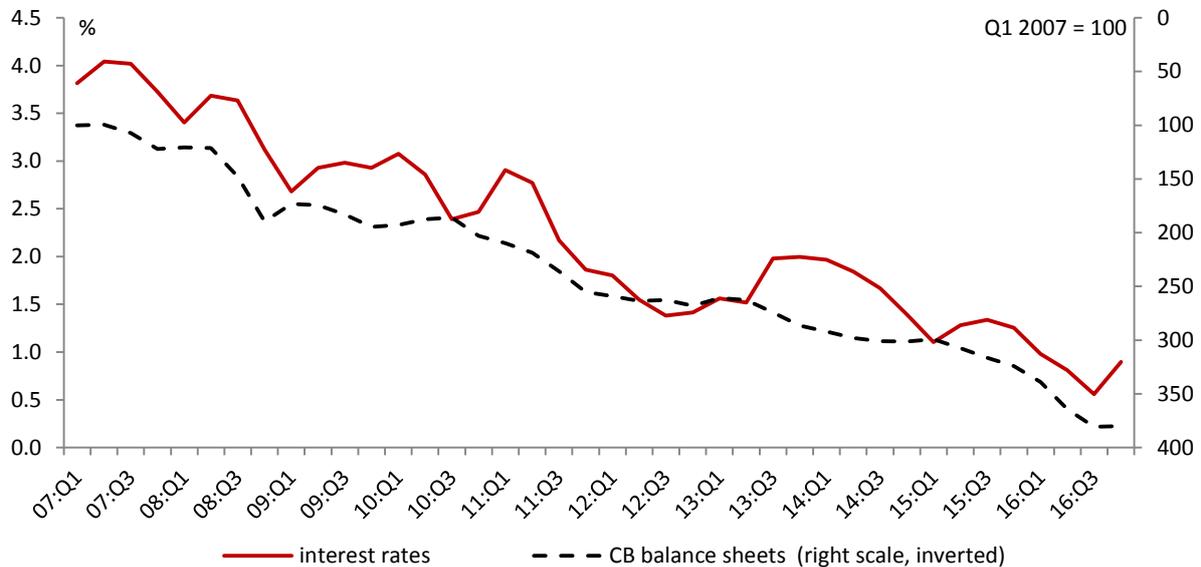
Figure 1, which shows the average 10-year government bond yield of the US, Japan, Germany and the UK and the expansion of balance sheets of their respective central banks.

¹ See Altavilla C., Carboni G. and Motto R. (2015), "Asset purchase programmes and financial markets: lessons from the euro area", ECB Working Paper No. 1864, for an analysis of the ECB's Asset Purchase Program (APP) between March 2015 and September 2016. The study predicts a reduction of 10-year Treasury yields of 47 basis points due to the APP. For the US, see, for instance,

Chadha J., Turner P. and Zampolli F. (2013), "The ties that bind: monetary policy and government debt management", *Oxford Review of Economic Policy*, 29(3): 548-581, who estimate an average reduction of 108 basis points of 10-year Treasury yields as a consequence of the Fed's first QE program. Generally, there is broad evidence suggesting that monetary policy influenced financial conditions in the years after the Great Financial Crisis, with the effects on output and inflation much harder to be pinned down. For an extensive review of the recent literature, see Borio, C. and Zabai, A. (2016), "Unconventional monetary policies: a re-appraisal", BIS Working Paper No 570.



Figure 1. Interest rates and central bank balance sheets*



* Average 10-year government bond yield of the U.S., Japan, Germany and the UK, and cumulated balance sheets of the Fed, BoJ, ECB and BoE.

Source: Haver Analytics

However, the decline in interest rate has not been associated with a rise in investment, as simple Keynesian investment theory would suggest. Figure 2 shows the same interest rates as in Figure 1 together with the ratio of investment to GDP in the advanced economies. Instead of going up after the Great Financial Crisis, as one would have expected, the investment ratio remained stable little above the level it had reached in recession even though interest rates continued to fall.

The simple Keynesian investment function, where lower interest rates lead to higher investment, is at odds with the investment theory of Modigliani and Miller.² These authors claim that it is the weighted average of the costs of debt and equity capital that influences an investment decisions. Because an increase in

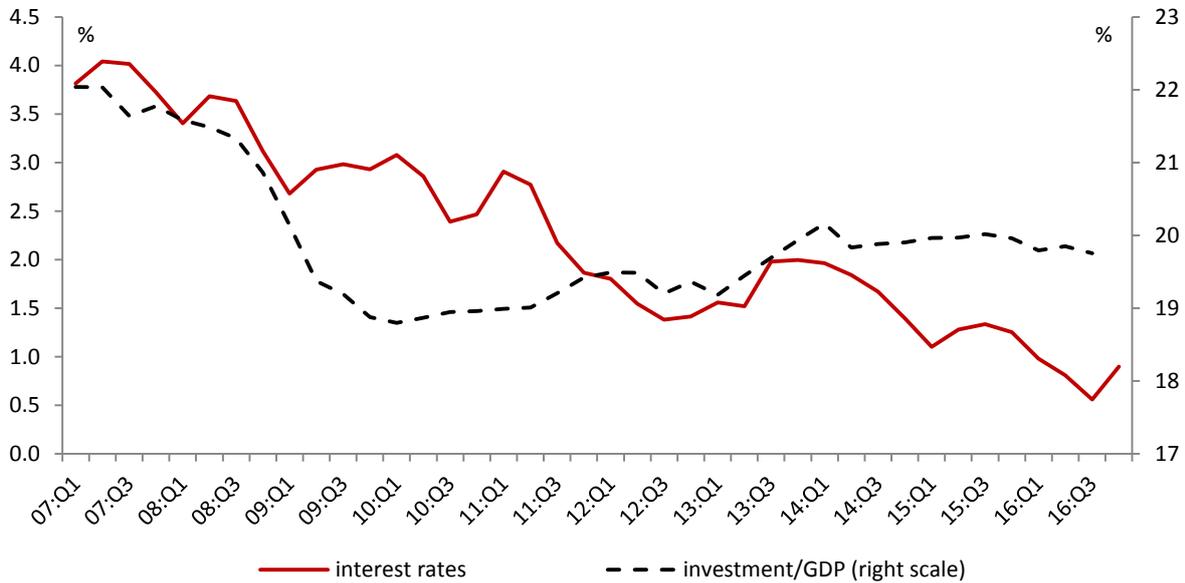
debt financing raises the risk premium on equity financing due to the rise in leverage, the weighted average costs of financing an investment (WACC) does not decline when interest rates fall.³ If the theorem of constant costs of capital of Modigliani and Miller were true, a reduction in the cost of debt financing would have no significant impact on investment spending by companies. In the following, we investigate the relationship between the WACC and interest rates, and the influence of these variables on investment.

² Modigliani F. and Miller M. (1958), "The cost of capital, corporation finance and the theory of investment", *American Economic Review*, 48(3): 261-297.

³ See the original model by Modigliani and Miller from 1958, in which tax benefits from interest payments and bankruptcy costs are excluded. In a subsequent model, known as the Modigliani-Miller's trade-off theory of leverage, the authors integrate taxes in their analysis, with the consequence that up to a certain threshold firms benefit from debt financing. While the extension of the model modifies the earlier results with regard to the capital structure of a firm, it does not affect the validity of the theorem of constant capital costs.



Figure 2. Interest rates and investment ratio*



* Average 10-year government bond yield and average investment/GDP ratio of the U.S., Japan, Germany and the UK.

Source: Haver Analytics

WACC and interest rates

In our analysis of the relationship between WACC and interest rates, we use firm-level data for 459 enterprises from 11 euro area member states in the period between 2007 and 2015.⁴ This is the largest sample of firms for which we could obtain data on WACC provided by Bloomberg.

Our estimation equation under the *WACC model* takes the following form:

$$WACC_{it} = \alpha + \beta_1 WACC_{it-1} + \beta_2 \mathbf{X}_{it} + \tau_t + \gamma_i + \varepsilon_{it} \quad (1)$$

where $WACC_{it-1}$ is the lagged dependent variable and \mathbf{X}_{it} is the vector of explanatory variables that we suppose to determine the WACC. Apart from interest rates we have included interest rate expenses of a firm, its credit ratings, and economic sentiment as a proxy for the macroeconomic environment. Coefficient α is the intercept, β_1 and β_2 are the coefficients of explanatory variables, τ_t and γ_i are the time and country fixed effects, respectively, and ε_{it} is the standard error of the estimates. Table 1 shows a few descriptive statistics of variables included in this model.

The inclusion of the lagged dependent variable on the right-hand side of the estimation equation controls for serial correlation of the dependent variable, but at the same time it could cause endogeneity in the estimation

⁴ These countries are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Luxembourg, Netherlands, Portugal and Spain.



Table 1. Summary statistics for the WACC model

Variable	Mean	Std. Dev.	Min.	Max.
WACC	7.8	5.1	0.5	28.1
10-year gov. bond yields	2.7	2.2	0.1	15.7
interest expense (in % of tot. rev.)	3.4	7.4	-20.9	85.5
Economic sentiment	97.7	10.0	70.0	116.9

Table 2. Estimation results of the WACC model

	WACC	WACC	WACC	WACC	WACC
l.WACC	0.094 (0.011)***	0.637 (0.022)***	0.637 (0.020)***	0.524 (0.043)***	0.468 (0.048)***
l.10year__int_rate	-0.027 (0.025)	0.011 (0.021)	-0.007 (0.023)	0.257 (0.097)***	0.059 (0.103)
l.interest_expense		0.000 (0.000)***	0.000 (0.000)***		
l.rating		0.151 (0.038)***	0.111 (0.039)***		
l.econ_sent			-0.000 (0.006)		
N	7,740	2,301	2,162	503	1,850
country fe	yes	yes	yes	yes	yes
time fe	yes	yes	yes	yes	yes
				Rating sub-IG	Rating IG
R-squared	0.075	0.722	0.751	0.774	0.720

Note: *, ** and *** are significance levels at 10%, 5% and 1%. Bootstrapped standard errors are in parenthesis.

equation. This is the reason why standard estimation methods and, specifically, fixed-effects methods, yield biased estimates.⁵ A consistent method developed to deal with dynamic panel data and with endogeneity issues is the so called corrected least square dummy variable estimator (LSDVC).⁶

⁵ This bias is known as the Nickell bias, as it was first identified by Stephen Nickell (1981), "Biases in dynamic models with fixed effects", *Econometrica: Journal of the Econometric Society*, 49: 1117-1126.

⁶ The method was first proposed by Jan Kiviet (1995), "On bias, inconsistency, and efficiency of various estimators in dynamic panel data models", *Journal of Econometrics*, 68: 53-78, as well as by Ruth Judson and Ann Owen (1999), "Estimating dynamic panel data models: a guide for macroeconometricists", *Economics Letters*, 65: 9-15. Monte Carlo simulations demonstrate that this method outperforms other consistent estimators, such as difference and system GMM estimators. In the Technical Appendix at the end of the paper, we provide an analytical explanation of the LSDVC method.

Table 2 gives the results of the estimation of equation (1). The estimation coefficient of long-term interest rates is insignificant. This holds also when we consider additional factors, such as firm-level interest expenses and firm-specific credit ratings⁷ (in the second column), as well as economic sentiment indicators (in the third column). However, the rating variable exerts a significantly positive effect: the worse the rating

⁷ Interest expenses are taken directly from the balance sheets and used as a proxy for the actual debt burden of companies. The rating variable reflects the rating by the leading agencies (we followed the S&P ratings, as reported by Thomson Reuters and Bloomberg). We converted the ratings grades into a five-grade scale: (1) – for high grade rating between AAA and AA-; (2) – for upper medium grade between A+ and A-; (3) – for lower medium grade between BBB+ and BBB-; (4) – for speculative and highly speculative non-investment grades between BB+ and B-; (5) – for the remaining non-investment grade categories between CCC+ and D.



(the higher the grade on our scale) the higher the WACC. Furthermore, the coefficient on interest expenses is statistically significant, but its economic significance (given by the size of the coefficient) is negligible. In the last two columns of Table 2, we analyze whether the lack of effects of interest rates on the WACC holds for firms with different credit ratings. This seems to be the case. Lower interest rates improved financing conditions of firms with doubtful (sub-investment grade) ratings, but not of firms with investment grade ratings. Thus, overall, our results are in line with the theorem of Modigliani-Miller. If anything, the policy of low interest rates has helped low quality firms to fund their activities, but it has not raised investment in the aggregate.

WACC and investment

The estimation equation has the following form:

$$\begin{aligned} invest_{it} = & \alpha + \beta_1 invest_{it-1} + \beta_2 x_{it} + \\ & + \tau_t + \gamma_i + \varepsilon_{it} \end{aligned} \quad (2)$$

where $invest_{it-1}$ is the lagged dependent variable, x_{it} is either the long-term interest rate or the WACC. Coefficient α is the intercept, β_1 and β_2 are the coefficients on explanatory variables to be estimated, τ_t and γ_i are the time and country fixed effects, respectively, and ε_{it} is the standard error of the estimation equation.

For the same reason as before, we estimate the investment model with the LSDVC estimator.

To estimate the equation, we collected country-level data for 11 euro area member states for which observations between 2007 and 2015 were available.⁸ The dependent variable is the growth rate in real gross fixed capital formation (at chained 2014 values), which approximates new investment. The main explanatory variable is either the level of long-term interest rates or the value of the WACC. We approximated the former with 10-year government bond yields. The WACC is originally obtained from the balance sheets of individual companies and expressed here as country-level averages. The data on investment and interest rates come from Haver Analytics, whereas information on the WACC is taken from Bloomberg. Table 3 shows summary statistics of the variables included in the model.

Table 4 summarizes the estimation results. It should be noted that we use the contemporaneous observations for WACC, whereas we lag the long-term interest rate by one year. This is because the WACC as reported in the firms' balance sheets at time t is based on information observed in the past. For the long-term interest rate, we aim at allowing a one-year lag period for the effects on investment to work out.

⁸ The countries in the sample are the same as in the previous estimations. See also footnote 4 for the full list of countries.



Table 3. Summary statistics for the *investment model*

Variable	Mean	Std. Dev.	Min.	Max.
<i>Invest</i>	-0.6	8.9	-23.5	32.5
<i>10-year gov. bond yields</i>	2.7	2.2	0.1	15.7
<i>WACC</i>	6.1	3.3	1.0	17.3

Table 4. Estimation results of the *investment model*

	invest	invest
<i>l.invest</i>	0.765 (0.131)***	0.580 (0.112)***
<i>wacc</i>		-0.800 (0.396)**
<i>l.10year_int_rate</i>	0.563 (0.441)	
<i>N</i>	85	88
<i>country fe</i>	yes	yes
<i>time fe</i>	yes	yes
<i>R-squared</i>	0.554	0.645

Note: *, ** and *** are significance levels at 10%, 5% and 1%. Bootstrapped standard errors are in parenthesis.

The estimates show that in 2007-2015, when interest rates were pushed down by the extremely expansionary monetary of the ECB, the long-term interest rate did not exert a significant influence on real investment (first column). Instead, the WACC was significantly driving investment spending by firms in the euro area. As the WACC came down only little over the investigation period, investment growth was relatively weak (Figure 3). Thus, our results reject the notion that lower interest rates can lift investment growth and, instead, support the investment theory of Modigliani-Miller.

Conclusion

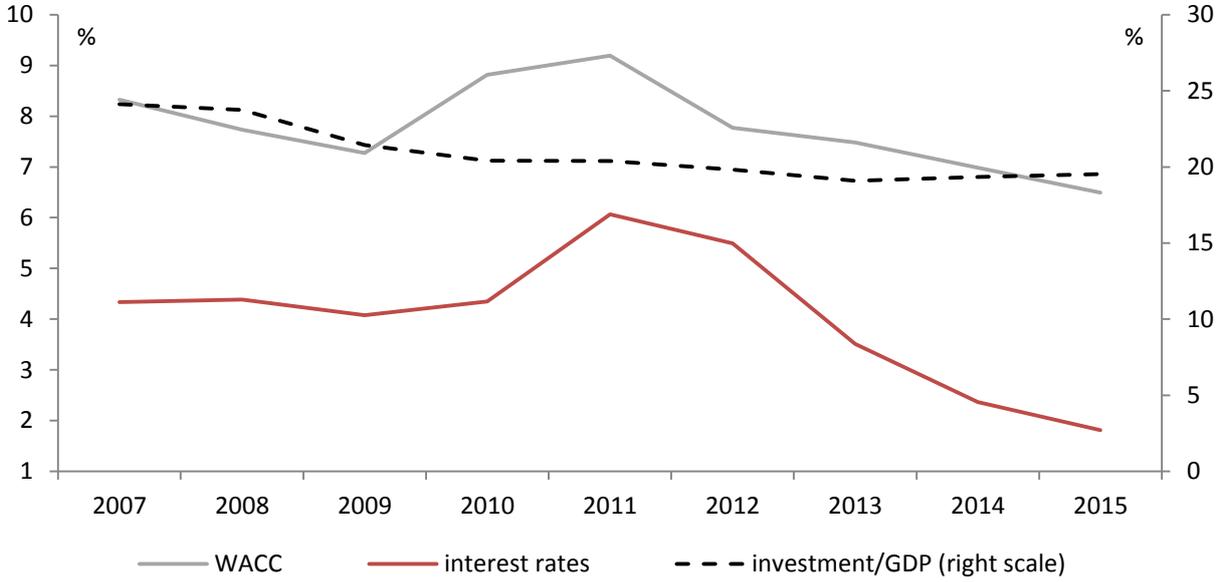
Central banks have made strong efforts to lift investment growth of companies by depressing interest rates. Their policy may have been guided by the Keynesian investment function, where lower interest rates are seen to induce higher investment. However, according to the theorem of constant capital costs established by

Modigliani and Miller, lower interest rates simply raise the equity costs of capital due to a higher risk premium as a result of more leverage.⁹ This seems to have been the case in practice. Our estimates have shown that the weighted average costs of capital (WACC) were in general not driven down by declining interest rates. The only beneficiaries of falling costs of debt capital were firms with a credit rating below investment grade. Our estimates have also shown that it is WACC and not interest rates that have a significant influence on investment. Hence, both theory and empirical analysis suggest that the low interest rate policy of central banks has been ineffective in boosting real investment.

⁹ This is shown in the analysis of Lehmann, K. (2015), "Investitionsschwäche trotz Niedrigzinsen – Kalkulatorische Kapitalkosten als Hemmschuh?" Flossbach von Storch Research Institute, Unternehmensanalyse No. 20/11/2015.



Figure 3. Investment, WACC and interest rates on average in the analyzed sample



Source: Haver Analytics (investment and interest rates) and Bloomberg (WACC)



Technical Appendix

Assume an autoregressive panel data model (AR(1)) with observations across units (countries, sectors, firms) and over time. The underlying model takes the following general form:

$$\mathbf{y} = \alpha\mathbf{X} + \vartheta\mathbf{D} + \omega$$

where \mathbf{y} is the vector of individual, time-specific observations of the dependent variable, \mathbf{X} is the matrix of explanatory variables, including the lagged dependent variable, α refers to the corresponding vector of coefficients, \mathbf{D} is the matrix of individual dummies, ϑ represents the corresponding vector of individual effects, and ω is the idiosyncratic error term. The (uncorrected) LSDV estimator is then given by

$$\eta_{LSDV} = (\mathbf{X}'\mathbf{A}\mathbf{X})^{-1}\mathbf{X}'\mathbf{A}\mathbf{y}$$

where \mathbf{A} is the transformation matrix wiping out the individual effects. By including the lagged dependent variable in the estimation framework, this estimator becomes consistent due to a bias, which was derived analytically and described by Bun and Kiviet (2003).¹⁰

By subtracting this bias from the above expression of LSDV estimator one obtains its corrected form, which we apply in our estimations:

$$LSDVC = LSDV - bias.$$

The correction procedure requires that the estimation has to be performed with one among three standard consistent estimators, namely, the Anderson and Hsiao (1982), the Arellano and Bond (1991), or the Blundell and Bond (1998) method.¹¹ All three are asymptotically equivalent. We used Blundell and Bond (1998) as our initial estimator. Moreover, as an additional improvement, we bootstrap the standard errors, in order to overcome the issue of poor approximation of the estimated standard errors.

¹⁰ Maurice Bun and Jan Kiviet (2003), "On the diminishing returns of higher-order terms in asymptotic expansions of bias", *Economics Letters*, 79: 145-152.

¹¹ Theodore Anderson and Cheng Hsiao (1982), "Formulation and estimation of dynamic models using panel data", *Journal of Econometrics*, 18: 47-82; Manuel Arellano and Stephen Bond (1991), "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", *Review of Economic Studies*, 58: 277-297; Richard Blundell and Stephen Bond (1998), "Initial conditions and moment restrictions in dynamic panel data models", *Journal of Econometrics*, 87: 115-143.



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