Essays on Monetary Policy, Investors and Elections

Inauguraldissertation
zur Erlangung des akademischen Grades
eines Doktors der Wirtschaftswissenschaften
der Universität Mannheim

vorgelegt von

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im FSS 2018

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Tag der mündlichen Prüfung: 5. Oktober 2018

Acknowledgements

First and foremost, I would like to thank my supervisor Hans Peter Grüner for his support and guidance during the past six years, starting with the supervision of my Bachelor Thesis. I am extremely grateful for the superb research environment he provided throughout the years, and his openness and support for all my endeavours during the research phase. I would also like to thank Carsten Trenkler for his comments on the first two chapters in particular. I am very grateful for his support and advice during the final stages of thesis writing.

In Mannheim I had the pleasure to work with my co-author Nikolay Marinov – a very fruitful collaboration that has lead to an APSR publication and a book deal with Cambridge University Press. I had a lot of fun working alongside my office mates Wieland Hoffmann, Felix Jarman, Sven Simon and Sihong Zhang, as well as my office neighbours Tobias Etzel, Fabian Greimel, Christoph Siemroth and Inken Töwe. Their help and advice was very much appreciated. I also want to thank my CDSE friends Esteban Cattaneo, Torben Fischer, Marcel Preuß, Max Todtenhaupt and many others with whom I have talked about my research.

The Financial Research Division of the European Central Bank has been a great environment during my 17 months at the ECB. I had the pleasure to acquire great co-authors: Maurizio Habib, Angela Maddaloni, Simone Manganelli, and José Luis Peydró. At the ECB I had a great time sharing my office with Annika Bacher, Veronica de Falco, Claudio Hantzsche, Carlo Medici and François Miguet.

I am also grateful to Astrid Reich and Sylvia Rosenkranz for making academic life so much easier, as well as Sandro Holzheimer, Marion Lehnert and Dagmar Röttsches from the CDSE. Finally, I would like to thank my parents Ruth and Jürgen, my brother Felix, my girlfriend Annika, and all who I could not mention here.

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General Introduction

This dissertation consists of three self-contained chapters. The common theme is the anlaysis of the effects of powerful outside influencers such as central banks or states on the investment decisions or voting outcomes of individuals. In chapter 1, I look at the effects of monetary policy uncertainty on the withdrawal behaviour of the investors in (corporate) bond funds, both from a theoretical and an empirical perspective. In chapter 2 (co-authored with Maurizio Michael Habib and Simone Manganelli), we analyze the effects of ECB monetary policy announcements on the portfolio of euro area fund investors. Chapter 3 (co-authored with Nikolay Marinov) models the role of outside powers in the electoral process. Brief summaries of the chapters follow.

Chapter 1

Monetary Policy Uncertainty and Financial Stability: Withdrawal Incentives in Corporate Bond Funds

This chapter looks at monetary policy uncertainty and its repercussions on financial stability from the perspective of the investors in a corporate bond fund. In the context of a model of a bond fund run, I focus on changes in fundamental uncertainty. I contrast the predictions of my model in settings both with and without strategic complementarities with certain empirical patterns. I extract a novel measure of monetary policy uncertainty from official FOMC communications. This measure can be understood analogous to a private signal, consisting of both a mean and a variance.

I test a number of theoretical predictions using a sample of U.S.-domiciled corporate bond funds. Instead of focusing on (unexpected) changes in the level of monetary policy from a portfolio perspective as in the subsequent chapter, this chapter looks at the effects of monetary policy uncertainty on outflows from certain types of mutual funds – corporate bond funds – that should be characterized by a relatively high degree of strategic complementarities.

I find that the average prediction of FOMC members with respect to the future level of interest rates is associated with higher withdrawals. This holds both for funds mainly investing in corporate bond funds and those that mainly invest in government bond funds. A higher level of uncertainty in the predictions of the future level of the interest rate is associated with inflows into corporate bond funds. There is no evidence of a positive effect on the flows of government bond funds. This is consistent with the model's predictions for a moderate level of strategic complementarities in corporate bond funds. In the absence of strategic complementarities increasing uncertainty can have the opposing effects. This might explain the differing withdrawal patterns from government bond funds.

Chapter 2
The Portfolio of Euro Area Fund Investors and ECB Monetary Policy Announcements

This chapter has been written during my time at the Financial Research Division of the ECB and is joint work with Maurizio Michael Habib and Simone Manganelli. It has been conditionally accepted for publication in the Journal of International Money and Finance.

We study the impact of ECB monetary policy surprises on the portfolio allocation of euro area fund investors. Our daily dataset covers the period between 2012 and mid-2016. Our findings show that ECB monetary policy affected fund investors mainly via its impact on asset prices and exchange rates. Overall, we find little evidence of investors actively reallocating their portfolio in the aftermath of significant monetary policy announcements.

In order to study the impact of ECB policies on the portfolio of euro area investors, we track the evolution of an aggregate portfolio of investment funds that are based in Luxembourg, the largest financial centre for the euro area investment fund industry, which mainly attracts euro area investors. We study how investors, on aggregate, choose investment funds at the fund category level. To identify the relevance of the different channels of transmission, we construct measures of *active* portfolio reallocation, driven by the redemptions or injections of underlying investors, and of *passive* portfolio reallocation, triggered by valuation effects related to changes in asset prices and exchange rates. As common in the literature on the impact of monetary policy decisions, we identify the announcement effects of traditional and unconventional policies by looking at the intraday change in key euro area interest rates around major events, such as ECB Governing Council meetings.

The significant valuation effects associated with these price movements *passively* shifted the asset allocation of euro area investors towards riskier securities, like funds investing in European and Emerging Market equity, and away from European bond funds. These effects are more pronounced for unconventional measures, such as the Asset Purchase Programme (APP). Some *active* reallocation into emerging equity markets following ECB actions is observed for institutional investors. Overall, our daily reallocation measures capture reallocation mostly at the margin.

Chapter 3

Process or Candidate: The International Community and the Demand for Electoral Integrity

This chapter is joint work with Nikolay Marinov and has been published in the American Political Science Review. We introduce a conceptual distinction between processes, the "how" of elections, and parties competing in them, the "who" of elections. We use this distinction to develop a theory of electoral intervention. The theory is built on a formal model of elections with bias. Domestic parties compete for office using their resources and popularity. Whether they win or not is also a function of the institutional rules of the game. Outsiders have a choice of investing in the how, the who, or both. Outside actors care about cleaner (more legitimate) contests and about the policy platform of the prospective leaders.

The model produces predictions on three quantities of interest: the amount and mix of resources invested by the outsider in the election, incumbent win or loss, and the degree of fraud (or compliance with democratic rules). A key insight we seek to convey is that outsiders' interest in elections of other countries can be conceived of as a mixture of two types of concerns: geo-politics and democratic liberalism. We show why outside powers would not invest exclusively in one strategy, i.e., the "how", or the "who" in elections. We also allow for the strategic adjustment of the behaviour of one power in anticipation of the response of another power. We call these scenarios "election wars".

Chapter 1

Monetary Policy Uncertainty and Financial Stability: Withdrawal Incentives in Corporate Bond Funds

1.1 Introduction

While the Federal Reserve has kept its policy rate unchanged for exactly 7 years between December 2008 and December 2015, the ECB lowered its deposit facility rate to -0.4 in March 2016 and has kept it at this level to date (June 2018). During these periods – apart from educating the public on unprecedented asset purchase programmes – central bank actions with respect to policy rates have been focused on the communication of the future path of interest rates. This has lead to episodes of differing uncertainty with respect to the future level of interest rates. Implicit and explicit forward guidance have essentially converted uncertainty into one of the main policy instruments of central banks.

In financial markets, uncertainty has a large influence on the decisions of each agent. In addition to uncertainty about the future state of the economy (fundamental uncertainty), market participants face uncertainty about the actions of others that might affect the payoffs of their own decisions (strategic uncertainty). Most theoretical models of run phenomena look at settings in which strategic uncertainty is the dominant factor, and focus on changes in the latter, driven e.g. by differences in the liquidity of certain assets. The models' predictions are then usually contrasted with the long-run empirical evidence (e.g. Chen et al. (2010) or Goldstein et al. (2017)).

This paper looks at monetary policy uncertainty and its repercussions on financial stability from the perspective of the investors in a corporate bond fund. In the context of a model of a bond fund run, I will focus on changes in fundamental uncertainty. I will contrast the predictions of my model with certain empirical patterns in settings both with and without strategic complementarities. Based on the degree of unanimity in the FOMC "dot plots"[1] (cf. Figure 1.1) I extract a novel measure of monetary policy uncertainty from official FOMC communications. This measure can be understood analogous to a private signal, and consists of both a mean and a variance. I test a number of theoretical predictions using a sample of U.S.-domiciled corporate bond funds. Instead of focusing on (unexpected) changes in the level of monetary policy from a portfolio perspective, see e.g. Bubeck et al. (2017) or Koijen et al. (2017), this paper looks at the effects of monetary policy uncertainty on outflows from corporate bond funds – funds that should be characterized by a relatively high degree of strategic complementarities. I revisit three different strands of the literature and provide several connections.

First, flows of mutual funds have been studied extensively (Sirri and Tufano, 1998; Edelen, 1999; Greene et al., 2007; Chen et al., 2010).[2] Recently the focus has shifted to corporate bond funds (Chen and Qin, 2017; Goldstein et al., 2017). So far however the effects of uncertainty have not been studied in the context of mutual funds – even though the early literature on coordination problems in macroeconomics (Morris and Shin, 2002) has placed a lot of emphasis on this particular feature. Additionally, in classic portfolio selection problems uncertainty (usually proxied by past volatility) plays a key role (Levy and Markowitz, 1979). This paper studies the effects of uncertainty on mutual fund flows in a run framework.

Second, there is an extensive literature on runs. The seminal contribution of Goldstein and Pauzner (2005) derives a unique equilibrium in the bank run framework of Diamond and Dybvig (1983) and looks at the limiting case of uncertainty $\varepsilon \to 0$, which leads to the coordination of investors on the *Laplacian* action as outlined in Morris and Shin (2003) or Angeletos and Lian (2016).[3] Most of the follow-up theory papers that study the behaviour of depositors and investors use refined global games techniques to pin down investor beliefs.[4] This paper studies the effects of uncertainty *away* from the limiting case in a coordination problem among the investors of a corporate bond fund – both theoretically and empirically.

Third, recent developments in the conduct of monetary policy have inspired a small theoretical[5] and empirical literature centered around the concept of monetary policy uncertainty.

[1]Essentially the "dot plots" are a form of cheap talk or non-binding communication. However reputational concerns of the central bank etc. might make the statements binding to a certain extent. The question how the single dots are aggregated into future policies is an interesting follow-up question. Grüner and Kiel (2004) look at the influence of different aggregation mechanisms on the distribution of reports of the individual agents.

[2]Greene et al. (2007) includes an analysis of analysis of the effects of redemption policies on fund flows.

[3]Hence, in this class of theoretical models the precision of the private signal that agents receive, has no influence on the equilibrium action of the agents. At the same time, the infinitely precise signal essentially removes any remaining uncertainty with respect to fundamentals.

[4]How certain assumptions influence the selection of the equilibrium is described in Frankel et al. (2003). This particular feature has been questioned by Weinstein and Yildiz (2007) and subsequent generalizations have been proposed by Morris et al. (2016)

[5]Sinha (2016) looks at the effects of monetary policy uncertainty shocks in a New-Keynesian DSGE model. Campbell et al. (2014) look at its effects on the risk properties of US Treasury bonds in a New Keynesian macro model.

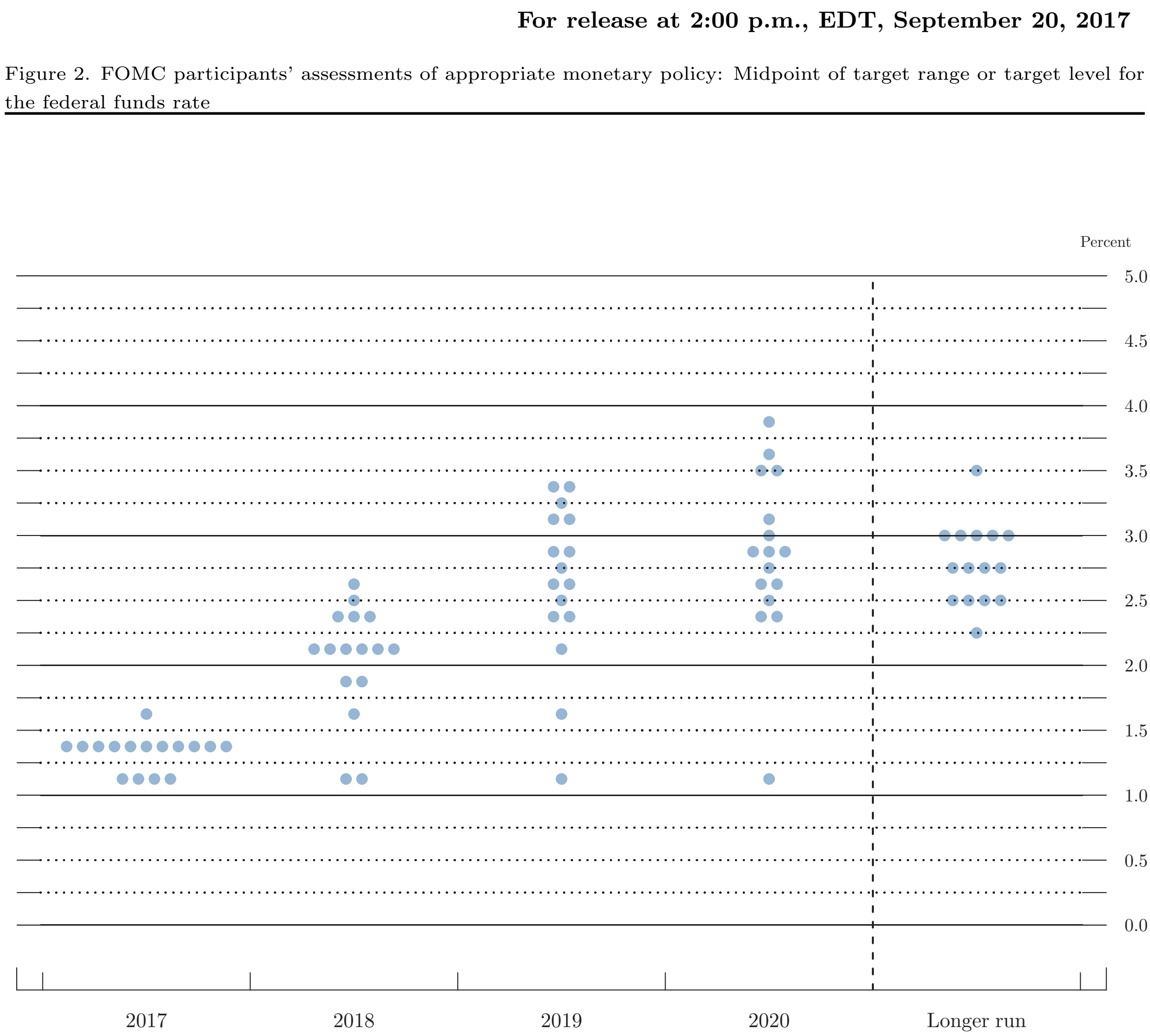


Figure 1.1: September 2017 FOMC "dot plot" published by the Federal Reserve
Source: `https://www.federalreserve.gov/monetarypolicy/files/fomcprojtabl20170920.pdf`

Approaches to measure uncertainty based on both the implied volatility computed from option prices and the realized volatility computed from intraday prices of interest rate futures (Chang and Feunou, 2013) have been proposed alongside news-based measures (Husted et al., 2017). Finally the effects of monetary policy uncertainty on financial market prices (Kurov and Stan, 2018), term premia (Bundick et al., 2017) and macroeconomic outcomes (Istrefi and Mouabbi, 2017) have been studied. Monetary policy uncertainty is related to central bank transparency.[6] Frankel and Kartik (2018) and Tamura (2018) study the effects of the precision of central bank information in the classic setup where output and inflation are the outcomes – similar to the framework of Barro and Gordon (1983), Cukierman and Meltzer (1986) and Grüner (2002). My aim is to look at the effects of monetary policy uncertainty on financial stability in the context of run models.

Following the model of speculative attacks on currency pegs (Morris and Shin, 1998)

[6]For a summary see Geraats (2002).

there have been various papers that focus on the role of public and private information in such settings: Heinemann and Illing (2002), Metz (2002), Hellwig (2002), Morris and Shin (2004) and Bannier and Heinemann (2005). In the context of regime change games and information "manipulation" by the incumbent government, this literature has recently been revived: Edmond (2013), Iachan and Nenov (2015) and Ahnert and Kakhbod (2017).[7]

The framework that studies runs driven by fundamentals has been established by Goldstein and Pauzner (2005). This framework has been extended in various ways. Matta and Perotti (2016) derive an equilibrium under liquidity risk that is correlated with fundamental risk, but conceptually different. Moreno and Takalo (2016) look at optimal (welfare-maximizing) transparency in a run environment with uniformly distributed noise, two-sided strategic complementarities and monotone payoffs in case of withdrawal. An extension endogenizes the risk choice of banks. There have been a number of extensions that look specifically at (mutual) funds: Liu and Mello (2011) derive the optimal cash holdings of a (hedge) fund with a fixed return under uncertainty with respect to the fraction of redemptions. Chen et al. (2010) use a theory model to motivate their empirical findings on the flow-performance relationship of equity mutual funds. This model has been extended by Lewrick and Schanz (2017a) to cover flow-induced price adjustments of mutual fund shares, commonly known as "swing pricing".[8] Morris et al. (2017) use a reduced form version of the model of Chen et al. (2010) to study endogenous cash choices of fund managers. Similarly Schmidt et al. (2016) report comparative statics on the effects of a change in the fraction of informed agents on the run threshold in money market funds. These are derived in a simple Gaussian global games setup. Morris and Shin (2016) look at fund managers' adjustments of their bond holdings under "last-place aversion" when funds are susceptible to runs. A simplified version of this model is used in Feroli et al. (2014) to motivate the empirical evidence on market tantrums and monetary policy that the authors present. Except Moreno and Takalo (2016) and Schmidt et al. (2016) all papers use a global games framework under vanishing noise.

Similarities between bank runs and the strategic considerations of fund investors have been pointed out among others by Jeremy Stein in 2014: "So much activity in open-end corporate bond and loan funds is a little bit bank like. [...] It may be the essence of shadow banking [...] giving people a liquid claim on illiquid assets."[9] Much earlier, Markus Brunnermeier (2009) has argued that models that involve run incentives may extend to

---

[7] Among recent working papers using a Gaussian structure are: Szkup (2014) derives comparative statics in "simple" global games. Kolbin (2015) looks at the choice of precision of communication by a government, both under commitment and without commitment, Quigley and Toscani (2016) focus on the role of public information.

[8] The same authors study optimal swing pricing rules in a general equilibrium framework without informative signals in Lewrick and Schanz (2017b).

[9] "Fed looks at exit fees on bond funds"; Financial Times; June 16, 2014; `https://www.ft.com/content/290ed010-f567-11e3-91a8-00144feabdc0` (obtained: 04/01/2018)

"equity holders, such as investors in a hedge fund or mutual funds". He argues that this is due to an "early-mover advantage [that] arises to the extent that fund managers sell liquid assets first" and hence "a first-mover advantage can make financial institutions in general, not only banks, subject to runs".

1.2 The model

I describe the withdrawal behaviour from bond funds in a simple model along the lines of Morris and Shin (2004) with two dates $t \in \{1, 2\}$ and a continuum of agents, called investors. Prior to $t = 1$ each investor contributes one unit of capital to the corporate bond fund. At $t = 1$ the investors have an alternative investment opportunity with a risky return that depends on the future monetary policy stance.

Agents may withdraw their funds at $t = 1$ in order to consume or to invest in the alternative asset. Alternatively they can remain with the fund until $t = 2$ and consume at this date. Below I describe in detail the corporate bond fund and the alternative investment opportunity.

1.2.1 Investors

There exists a continuum of investors with a mass normalized to $1 + \lambda$. Investors are endowed with a single unit of wealth. Prior to $t = 1$ agents invest all of their wealth in a bond fund for a duration of up to two periods. Agents are risk-averse and maximize their total consumption.

There are two types of investors, early investors (E) and late investors (L). Early investors have consumption needs at $t = 1$. Late investors value consumption only at date $t = 2$. Uncertainty about investor types is resolved at date $t = 1$, however each investor only learns her own type. With probability $\frac{\lambda}{1+\lambda}$ an investor is impatient and has consumption needs only in the first period. Her utility function is

$$u_E(c_1, c_2) = log(c_1).$$

Hence, withdrawing from the fund at $t = 1$ is always her dominant strategy. The remaining mass of agents is patient and derives utility from consumption at date $t = 2$.[10] These investors maximize

$$u_L(c_1, c_2) = log(c_2).$$

[10] Among others Sussman (1992) uses patient agents that only care about consumption in period 2. In my model, this ensures that investors cannot escape the effects of monetary policy.

Late investors face a choice between remaining with the fund, or investing in the alternative asset in order to transfer their wealth and consume at date $t = 2$.

1.2.2 Corporate bonds

An individual corporate bond of firm k is an asset that requires an upfront investment of 1 and generates a risky return when it matures at $t = 2$. There are two things that prevent investors from investing directly in corporate bonds:

- Individual corporate bonds are risky investments and it is hard for investors to assess the ex-ante probability of default p_k of firm k. The expected payment of an individual bond at $t = 2$ will be $R_k = p_k \cdot 0 + (1 - p_k) \cdot Q_k$, where Q_k indicates a repayment of the principal with interest. However, I assume that the return of a sufficiently diversified investment portfolio can be approximated by a safe return of R. Investors will prefer to invest in such a portfolio of bonds.

- Bonds are often issued with a minimum settlement amount in the order of magnitude of $100,000$ US-$. Hence no single retail investor is able to acquire a diversified portfolio via the primary market.

The secondary market for bonds has many particularities. Bloomberg estimates that about 80% of deals in corporate bonds are still done by phone or over a chat service.[11] Additionally, bonds are traded very infrequently. Citigroup estimates that out of the 26,000 publicly publicly registered bonds in 2014, 3,000 (11%) never traded at all over the course of the year and a further 5,000 (20%) traded on 5 days or fewer and just 277 (1%) traded daily.[12]

Due to the implied lack of reliable pricing information, it is reasonable to assume a price of $p_k < 1$ for individual bonds that have to be sold at date $t = 1$. A possible justification could be an adverse selection argument. Bonds that are for sale might be individual bonds with a particularly high p_k.

1.2.3 The alternative investment opportunity

There is an alternative investment opportunity (cash holdings in the second period) that requires one unit of capital at $t = 1$. The return of this alternative asset depends on the monetary policy stance Θ. Monetary policy has no direct influence on the payoff of bonds. The central bank reveals the true level of Θ after withdrawal decisions have been made by

[11] "Electronic Bond Trading Gains Ground," Bloomberg, 15 February 2018 (https://www.bloomberg.com/news/articles/2018-02-15/electronic-bond-trading-gains-ground-as-market-finally-matures)

[12] "When agents lose their principals – Fixed income liquidity revisited," Citi Research, August 2015

the investors. Late investors withdrawing at $t = 1$ need to invest in an asset with return Θ and consume $c_2 = \Theta$.

This implies that late investors will be affected by monetary policy. Either directly through the returns on the alternative investment or indirectly through the influence of monetary policy on withdrawals from the corporate bond fund.

1.2.4 The corporate bond fund

The bond fund enables agents to both invest in the bond portfolio and – if they turn out to be an early investor – fulfil their liquidity needs at date $t = 1$. The corporate bond fund cannot distinguish early investors from late investors. Prior to $t = 1$ the fund invests the contributions of its investors into a diversified portfolio of bonds that yields a safe return of R at date $t = 2$. The remainder of the fund's assets is kept in cash, in order to serve the anticipated amount of early withdrawals.

There is a mass of investors p_1 that withdraws at $t = 1$, the fund offers d_1. The remaining mass of investors $1 + \lambda - p_1$ redeems at $t = 2$ and obtains d_2. In order to serve early withdrawals the fund prefers cash holdings of $p_1 d_1$ over early liquidation of fund assets. The illiquid market for the assets of the fund implies that the bond fund cannot trade a fraction of the portfolio at a prices above 1. This assumption is also the driver of the strategic complementarities in the following.[13] The remaining funds $1 + \lambda - p_1 d_1$ are invested in bonds. Given cash holdings of $p_1 d_1$ feasible payoffs are those that fulfil:

$$(1 + \lambda - p_1 d_1)R \geq (1 + \lambda - p_1)d_2.$$

Early withdrawals $p_1 = \lambda + l$ can consist of early investors and late investors. For now, I want to derive the optimal contract the bond fund should offer for a given mass l of late investors that withdraw early.

$$\max_{d_1,d_2} E_\Theta \left[\frac{\lambda}{1+\lambda} log(d_1) + \frac{l}{1+\lambda} log(d_1\Theta) + \frac{1-l}{1+\lambda} log(d_2) \right].$$

Due to $log(d_1\Theta) = log(d_1) + log(\Theta)$ and the linearity of the expected value operator, this is equivalent to maximizing:

$$\max_{d_1,d_2} E_\Theta \left[\frac{l}{1+\lambda} log(\Theta) \right] + \frac{\lambda + l}{1+\lambda} log(d_1) + \frac{1-l}{1+\lambda} log(d_2).$$

[13] This assumption is similar to the assumption $0 < \alpha < 1$ in Liu and Mello (2011), combined with the assumption that the bond fund will never go bankrupt since withdrawals stay below a certain threshold, e.g. due to the inactivity of a large proportion of the investor population (Chen et al., 2010).

For a given d_1, the second period payoff depends on early withdrawals l and is denoted by:

$$d_2(l) = \frac{(1+\lambda-(\lambda+l)d_1)R}{1-l}$$

When plugging in the above feasibility constraint of the bond fund the maximization problem is solved by $d_1^* = 1$ and $d_2^* = R$.[14] This is driven by the assumption that cash holdings are $p_1 d_1$, implicit in the feasibility constraint, and the fact that the coefficient of relative risk aversion equals 1 for all c_1 and c_2. The managers of the bond fund know that the mass p_1 of agents withdrawing at date $t = 1$ is at least λ.

A more advanced contract design problem would specify an optimal schedule $d_1(l)$ and $d_2(l)$ instead of two deterministic payoffs, taking into account both monetary policy and the reaction of investors. Appendix A.1 outlines how one would solve a slightly more general version of this problem with late investors that react optimally to monetary policy and the deterministic choices of d_1 and d_2.

In the following I assume that the fund will offer the following contract:

Assumption 1. *The fund will never go bankrupt and offers $d_1(l) = 1$ to early redeemers.*

Without affecting the remaining investors, the fund can only pay $d_1 = 1$ using cash holdings. Hence, if $p_1 > \lambda$ the fund needs to liquidate some of its assets. However, since the fund's portfolio consists of illiquid corporate bonds that trade at $\alpha_k < 1$, unexpected liquidation is subject to a discount on the terminal value of the fund at date $t = 2$. I assume that the fund is always able to generate enough revenue in order to fulfil withdrawals at $t = 1$. In order to account for the illiquidity of the assets, the payoff of late redeemers $d_2(l)$ needs to be decreasing in l for $l > 0$. The no-bankruptcy assumption implies that the bond fund can sell its entire portfolio for a price of 1.

An alternative justification for $d_1 = 1$ would be mark-to-market pricing of the fund shares. Before anybody withdraws the fund can always offer $d_1 = 1$ by using cash reserves instead of quoting net asset values below 1.

To simplify matters, I will use a strictly monotone function for the second period payoff of the corporate bond fund, $d_2(l) = R \cdot e^{-\kappa l}$. The parameter $\kappa \in [0, 1]$ measures the strength of the externality that early withdrawals impose upon those remaining with the fund until date $t = 2$ caused by the illiquidity of the underlying assets. It holds that $\frac{\partial d_2(l)}{\partial l} = -\kappa R e^{-l} < 0$. A sufficient condition for the sum of the payoffs to be decreasing for in $l \in [0, 1]$ is $R > e^{\kappa}$.[15]

[14] The FOC is:

$$\frac{\lambda+l}{(1+\lambda)d_1} + \frac{-(\lambda+l)(1-l)R}{(1+\lambda)(1+\lambda-\lambda d_1)R} = 0.$$

Contrary to the assumptions of Diamond and Dybvig (1983), $u(c) = log(c)$ does not fulfil the condition that $RRA = -cu''(c)/u'(c) > 1$ since $RRA = 1$.

[15] It is desirable to assume that the total sum of the payoffs of the fund is decreasing in l, hence late

Assumption 2. *The fund offers $d_2(l) = R \cdot e^{-\kappa l}$ at date $t = 2$. Additionally it holds that $R > e^{\kappa}$.*

Setting $\kappa = 0$ shuts down strategic behaviour among the investors. Of particular interest will be scenarios with $\kappa > 0$. In these specifications the payoff of staying with the fund decreases in the proportion of investors that withdraw early.

Implicitly, this assumes a pricing schedule for fund assets that satisfies the following assumptions (i) the price of a fund asset is smaller than 1 for $l > 0$ and weakly larger than 1 for $l = 1$ (ii) the fund will never go bankrupt in the first period (iii) the price schedule implied by $d_2(l) = R \cdot e^{-\kappa l}$ is increasing in l. If one wants to maintain both (i) and (ii) without assuming that the potential fraction of withdrawals l has some upper bound that ensures that the fund never goes bankrupt in the first period, assumption (iii) needs to hold at least in the neighbourhood of $l = 1$. If the fund can go bankrupt already in the first period, this will lead to a non-monotonicity in the payoff of staying as in Goldstein and Pauzner (2005). The increasing price schedule could be justified by the fact that the market will assume that the fund will sell its most unattractive assets first. The larger the portfolio share that is liquidated by the fund, the higher the perceived average quality of the assets and hence the price the market is willing to pay for these.

1.2.5 Timing of actions and payoffs

Table 1.1: Payoffs of assets in the economy

		$t=0$	$t=1$	$t=2$
Individual bonds	Early liquidation	-1	$\alpha_k < 1$	0
	Held to maturity	-1	0	$(1-p_k)Q_k$
Bond portfolio	Early liquidation*	-1	$\alpha \leq 1$	0
	Held to maturity	-1	0	R
Bond fund	Early withdrawal	-1	1	0
	Held to maturity	-1	0	$Re^{-\kappa l}$
Cash holdings	First period	-1	1	0
	Second period	0	-1	Θ

*A price of $\alpha = 1$ can only be achieved by selling the entire portfolio.

Table 1.1 shows the payoffs of the assets available in the economy. Individual bonds can

redeemers receive $d_2(l)$ with $\frac{\partial d_2(l)}{\partial l} < 0$ and:

$$\frac{\partial \cdot}{\partial l} = \frac{\partial\left[(\lambda + l)d_1(l) + (1-l)\cdot d_2(l)\right]}{\partial l} < 0$$

be pooled in an joint portfolio and are sold as bond funds. Furthermore investors may hold cash.

Figure 1.2 summarizes the timing of the fund withdrawal game. Nature draws an agent's type. Subsequently agents decide between withdrawing and not withdrawing their fund shares. The most important element of the payoff structure are the strategic complementarities induced by the feature that the payoff of staying with the fund decreases in the amount of early withdrawals l.

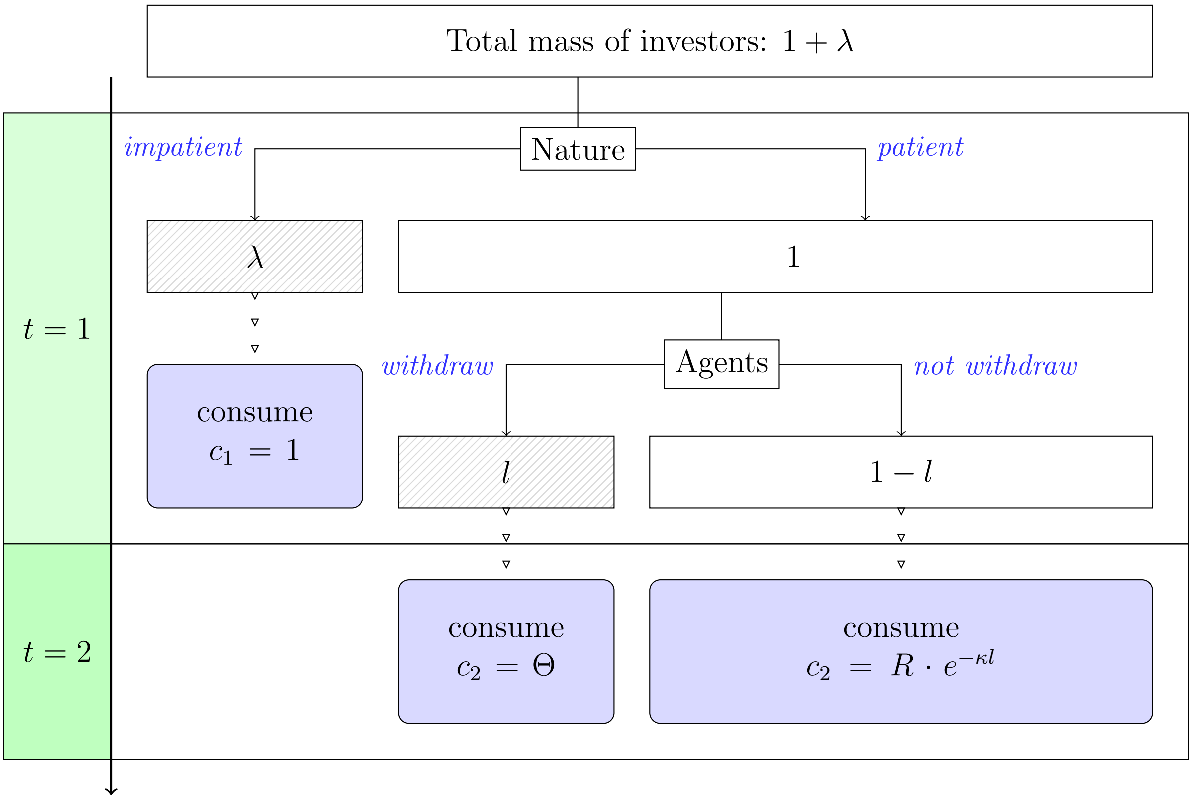


Figure 1.2: Timing of actions and payoffs

1.3 Solving the model

I will first solve a model without strategic complementarities. Then I will show how "strategic uncertainty", induced by the externalities that withdrawals impose upon the remaining investors of the fund, alters the behaviour of investors in equilibrium.

1.3.1 The late investor's problem

Each late investor faces a decision between redeeming at date $t=1$ and investing in the alternative asset or redeeming at $t=2$. If the investor liquidates her fund shares at $t=1$

she obtains a utility of

$$u_L = log(\Theta) = \theta.$$

She will consume the proceeds from withdrawing that have been re-invested into the storage technology. The returns of the storage technology are determined by the monetary policy stance Θ. If the investor remains with the fund her utility level will be

$$u_L = log\left(R \cdot e^{-\kappa l}\right) = log(R) - \kappa l = r - \kappa l.$$

This allows me to show the effects of changes in the information structure in an environment with a tractable payoff structure.

1.3.2 Information structure

The monetary policy stance θ is a random variable. It is distributed according to $\theta \sim N(\bar{\theta}, \alpha^{-1})$. The ex-ante distribution of the return of the alternative investment opportunity is common knowledge among all agents. The monetary policy stance θ is realized at date $t = 1$ but is unobserved by the agents.

Communication of central bank policies may not always be precise and might even be deliberately vague. As a consequence one would expect a certain level of dispersion in private information. I model this dispersion via private signals with variance $1/\beta$.

Before choosing between redemption dates, each investor receives a private signal x_i,

$$x_i = \theta + \varepsilon_i,\ \varepsilon_i \sim N(0, \beta^{-1}).$$

I assume that ε_i is i.i.d. across individuals and independent of θ. The parameter α denotes the precision of prior information and the parameter β denotes the precision of the private signal. The parameter $\bar{\theta}$ describes the expected level of monetary policy in the long run. In the short- and medium-term there might be random deviations from this level.

Upon observing her private signal x_i each agent will update her information ρ_i with respect to θ in the following way:

$$\rho_i = \frac{\alpha\bar{\theta} + \beta x_i}{\alpha + \beta}.$$

The posterior belief is the mean of the signal received by the agent and its prior mean $\bar{\theta}$, weighted by their relative precision. Hence the posterior distribution of θ is a normal distribution with mean ρ_i and variance $\frac{1}{\alpha+\beta}$.[16]

[16] A detailed proof of this Bayesian updating step in terms of its optimality for the case of a conjugate prior distribution (i.e. both the prior and the private signal are normally distributed) can be found in Theorem 9.5 of (DeGroot, 1970).

1.3.3 Optimal withdrawal without strategic complementarities

Setting $\kappa = 0$ switches off the externality that withdrawal from the fund imposes on the remaining investors. Hence, there is no coordination problem among investors. Implicitly, this assumes that assets of the corporate bond fund can be liquidated at a price of $\alpha = 1$. In this case, the withdrawal decision is purely driven by the investor's own signal with respect to the returns of the alternative asset.

Lemma 1. *A late investor withdraws her money from the corporate bond fund if*

$$E(\theta|\rho_i) = \rho_i \geq r.$$

Since the Bayesian posterior is a weighted mean of both the common prior and the private signal, both α and β have an influence on the withdrawal behaviour of investors. Since the payoffs do not depend on the behaviour of other investors, fundamental uncertainty is the only remaining source of uncertainty in this case.

1.3.4 Optimal withdrawal with strategic complementarities

For the case of optimal withdrawal under strategic complementarities, I describe the symmetric equilibrium in "switching strategies" around a threshold ρ^*. Investors' strategies map from public and private information into their action space. A switching strategy takes the form:

$$\sigma_i(\rho_i) = \begin{cases} \textit{withdraw} & \text{when } \rho_i \geq \rho^* \\ \textit{not withdraw} & \text{otherwise} \end{cases}$$

Agents withdraw their money from the fund, if the expected return from the alternative investment opportunity exceeds a threshold level ρ^*, and stay with the fund otherwise. If there is a unique equilibrium in switching strategies then this equilibrium is the only equilibrium that survives a process of iterative elimination of dominated strategies (cf. Appendix A.2).

Strategic complementarities turn the withdrawal decision of the agents into a Bayesian game. The optimal withdrawal decision of an agent depends on the withdrawal decisions of the other agents. Withdrawal is optimal whenever:

$$E(\theta|\rho_i) \geq E(r - \kappa l|\rho_i).$$

There is a threshold of individual beliefs ρ^* at which the agents are exactly indifferent between withdrawing and maintaining their investment with the corporate bond fund. For the marginal investor i with $\rho_i = \rho^*$ it holds that:

$$\rho^* = r - \kappa E(l|\rho^*).$$

In a symmetric equilibrium, given the marginal investor's belief ρ^*, the expected proportion of investors that withdraw is equal to the probability that any other agent's belief j is above this threshold:

$$\begin{aligned} P(\rho_j > \rho^* | \rho^*) &= P\Big(\tfrac{\alpha\bar{\theta}+\beta x_j}{\alpha+\beta} > \rho^* \Big| \rho^*\Big) \\ &= P\Big(x_j > \tfrac{\rho^*(\alpha+\beta)-\alpha\bar{\theta}}{\beta} \Big| \rho^*\Big) \\ &= 1 - \Phi\Big(\sqrt{\tfrac{\alpha^2(\alpha+\beta)}{\beta(\alpha+2\beta)}}\Big(\rho^* - \bar{\theta}\Big)\Big) \\ &= 1 - \Phi\Big(\sqrt{\gamma}\Big(\rho^* - \bar{\theta}\Big)\Big), \end{aligned}$$

where Φ denotes the c.d.f. of the standard normal distribution and I rewrite $\gamma = \frac{\alpha^2(\alpha+\beta)}{\beta(\alpha+2\beta)}$. Furthermore I use:

$$x_j | \rho^* = \theta | \rho^* + \varepsilon_j | \rho^* \sim N\Big(\rho^*, \frac{\alpha + 2\beta}{(\alpha+\beta)\beta}\Big).$$

This holds since signals are i.i.d. Hence another investor's ε_j is independent from the marginal investor's belief ρ^*.

Theorem 1. *For the corporate bond fund with strategic complementarities ($\kappa \neq 0$) there exists a unique symmetric equilibrium characterized by the run threshold ρ^* which solves:*

$$\frac{r - \rho^*}{\kappa} = 1 - \Phi\left(\sqrt{\gamma}\left(\rho^* - \bar{\theta}\right)\right).$$

A sufficient condition that ensures the uniqueness of the equilibrium is $\kappa^2\gamma < 2\pi$. Private signals need to be sufficiently precise compared to the prior, since γ increases in α and decreases in β. Furthermore, a higher degree of strategic complementarities requires private signals to be even more precise in oder to ensure a unique belief threshold.

The existence of other equilibria is ruled out in Appendix A.2 via iterative elimination of dominated strategies. The starting point of the proof is the existence of two dominance regions: below $\underline{\rho} = r - \kappa$ and above $\bar{\rho} = r$. In the graph the upper and lower bounds of these dominance regions are marked by the intersection of the 45°-line with the two dashed lines.

Figure 1.3 plots the tradeoff between withdrawing and maintaining the fund investment from the perspective of the marginal agent with belief ρ^*. The expected payoff of withdrawing is ρ^* while the expected payoff of not withdrawing is $r - \kappa\left(1 - \Phi\left(\sqrt{\gamma}\left(\rho^* - \bar{\theta}\right)\right)\right)$. At the optimal run threshold with respect to beliefs ρ^* the agent is indifferent between these two options.

Strategic complementarities lead to a strictly lower run threshold. This follows immediately from Theorem 1.

Lemma 2. *Theorem 1 implies $\rho^* < r$ for $\kappa > 0$ since $\kappa\left(1 - \Phi\left(\cdot\right)\right) > 0$.*

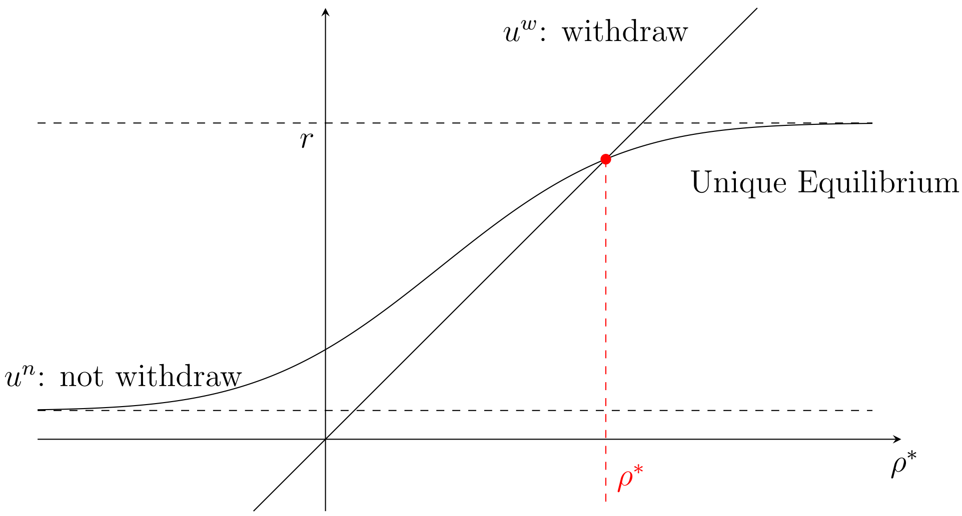


Figure 1.3: Equilibrium choice of run threshold ρ^* with $\kappa > 0$

Lemma 2 implies that strategic complementarities lead to higher withdrawals for any given realization of monetary policy θ.

1.4 Monetary policy

Having established a unique equilibrium in switching strategies, I will now turn to the analysis of comparative statics with respect to changes in the information structure. I have introduced θ as a parameter that is driven by the policy actions of a monetary authority, e.g. a central bank.

Policy actions are influenced by a latent unobserved factor that leads the central bank to randomly over- or undershoot its long-term policy $\bar{\theta}$. The central bank has built a certain expertise and/or reputation with respect to the implementation of monetary policy captured by the parameter α. This reputation could be driven by past performance or other institutional features. Jointly $\bar{\theta}$ and α determine the common prior of the investor population with respect to the policy actions of the central bank.

Given the realized monetary policy stance θ the central bank communicates its policy to investors via private signals $\theta + \varepsilon_i$. The degree of ambiguity in the communication of future policies is captured by a parameter β that denotes the precision of central bank communication. The parameter β denotes the inverse of the variance of the distribution of ε_i. This imprecision in communication leads to uncertainty with respect to the future level of interest rates.

I argue that this type of fundamental uncertainty resembles the deliberate attempts of various central banks to communicate their future policies – subject to a certain degree of uncertainty – via measures commonly known as "forward guidance". These central banks provide information on the future path of interest rates along with some information regarding the uncertainty of those predictions. The "dot plot" of the Federal Reserve is an example of such a policy. It contains information on the future path of interest rates. Additionally, the level of disagreement among FOMC participants indicates the level of uncertainty inherent in these communications.

The interaction between uncertainty about fundamentals, and strategic uncertainty, induced by complementarities among the actions of the agents, will be at the center of this section. Much of the attention in the literature has been placed on the effects of uncertainty in the limit, e.g. $\varepsilon_i \to 0$. This effectively eliminates uncertainty about fundamentals, such that uncertainty about strategic behaviour is the only remaining factor. I will look at the effects of uncertainty away from such limiting cases, contrasting the effects of pure fundamental uncertainty with the case in which both fundamental and strategic uncertainty matter for the final outcome.

1.4.1 Strategic withdrawal and the realized monetary policy stance

It follows from Lemma 2 that strategic complementarities lower the run threshold with respect to the beliefs of individual investors. The amount of withdrawals $l(\theta)$ is determined by the mass of agents that receive signals below the threshold signal $x^*\left(\rho^*, \bar{\theta}\right)$ which can be computed as:

$$x^*\left(\rho^*, \bar{\theta}\right) = \frac{\alpha + \beta}{\beta}\rho^* - \frac{\alpha}{\beta}\bar{\theta}.$$

Since $x_i = \theta + \epsilon_i$ is normally distributed with $\epsilon_i \sim N(0, \frac{1}{\beta})$, I can express withdrawals $l(\theta)$ at a given a realization of θ as:

$$\begin{aligned} l(\theta) &= P\Big(x_i > x^*(\rho^*, \bar{\theta})\Big) \\ &= 1 - \Phi\Big(\sqrt{\beta}\Big(x^*(\rho^*, \bar{\theta}) - \theta\Big)\Big). \end{aligned}$$

Furthermore $\rho^* < r$ implies that $l'(\theta) = P\Big(x_i > x^*(r, \bar{\theta})\Big) < l(\theta)$. This pins down the effects of strategic uncertainty on the withdrawal behaviour of agents. Figure 1.4 shows that strategic complementarities shift the entire withdrawal schedule to the left and increase the amount of withdrawals at any given realization of θ.

The graph of $l(\theta)$ in Figure 1.4 shows three areas in which small changes in the realization of θ have different consequences. For small realizations of θ not running is an almost "stable" outcome while for very large θ the money will always be withdrawn almost in full. Small changes barely affect these outcomes. For intermediate values around the signal threshold $x^*(\rho^*, \bar{\theta})$, however, a small change in the realization of θ has a larger effect on withdrawals. Notably, these non-linearities are also present in the case without strategic complementarities.

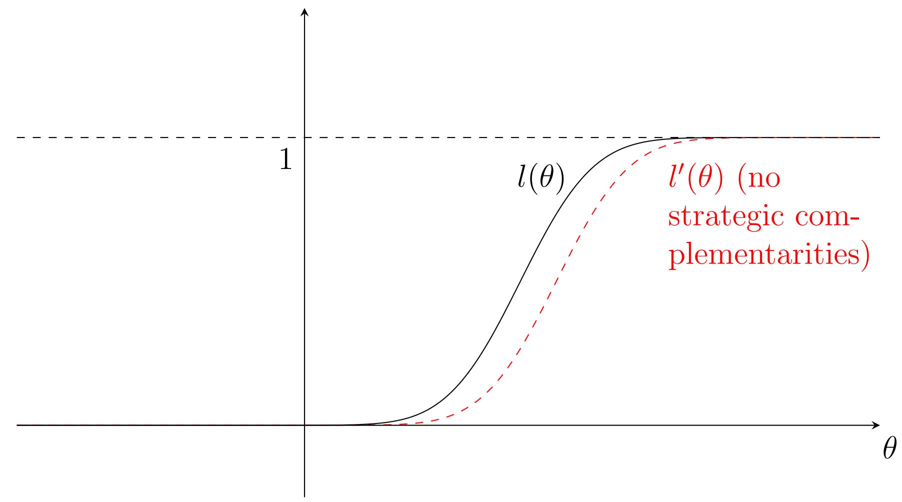


Figure 1.4: Incidence of withdrawals $l(\theta)$

1.4.2 The role of the prior expectation $\bar{\theta}$

A shift in the prior expectation $\bar{\theta}$ affects withdrawals via two channels. First, it lowers the run threshold ρ^*. An increase in $\bar{\theta}$ shifts $r - \kappa \left(1 - \Phi\left(\sqrt{\gamma}\left(\rho^* - \bar{\theta}\right)\right)\right)$ to the right. It is now optimal to choose a lower run threshold. Since the function $r - \kappa \left(1 - \Phi\left(\sqrt{\gamma}\left(\rho^* - \bar{\theta}\right)\right)\right)$ is monotonously decreasing in $\bar{\theta}$, the effect does not depend on additional parameters. However, since it is not possible to solve for ρ^* in closed form it is not possible to provide evidence on the comparative statics of ρ^* in the form of derivatives.

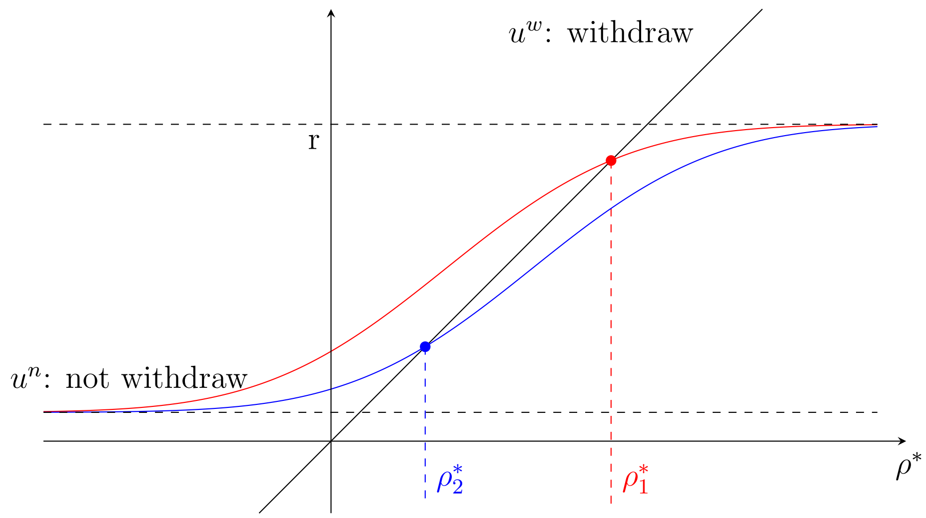


Figure 1.5: A higher level of $\bar{\theta}$ lowers the run threshold ρ^* ($\bar{\theta}_2 > \bar{\theta}_1$)

Additionally, due to the increase in $\bar{\theta}$ (e.g. $\bar{\theta}_2 > \bar{\theta}_1$) the threshold signal is lower even without strategic complementarities ($\kappa = 0$). It holds that $x^*(r, \bar{\theta}_2) < x^*(r, \bar{\theta}_1)$. The negative effect on the run threshold ρ^* sketched in Figure 1.5 lowers the threshold signal even further. The financial stability effects of higher expected interest rates are exacerbated by strategic complementarities.

This illustrates the importance of expectations for the emergence of a run. Assume two situations in which agents have received exactly the same signal distribution, but had different ex-ante expectations. Both the indirect effect via the decrease in ρ^* and the direct effect of the increase in $\bar{\theta}$ on the threshold signal lower $x^*(\rho^*, \bar{\theta})$. Therefore an increase in $\bar{\theta}$ will lead to a higher fraction of the population joining the run. Strategic complementarities exacerbate these effects.

1.4.3 Monetary policy uncertainty

I argue that central banks may influence uncertainty via the precision of central bank communication. This directly affects investor beliefs. Higher monetary policy uncertainty leads to a lower value of the parameter β.[17]

Higher uncertainty in the private signal decreases the uncertainty about the expected proportion of agents with beliefs higher than the threshold ρ^*. Agents put more weight on the common prior and hence beliefs are more similar. While higher monetary policy uncertainty increases the uncertainty about fundamentals, it decreases strategic uncertainty – uncertainty about the actions of others.

The effects on the run threshold, however, depend on the prior expectation $\bar{\theta}$ in this case. Figure 1.6 shows that if the marginal investor's belief lies above $\bar{\theta}$, higher monetary policy uncertainty will lead to a higher run threshold ρ^*. This will be the case whenever $\bar{\theta} < r - \frac{\kappa}{2}$, i.e. expected monetary policy is at a relatively low level compared to the returns from the corporate bond fund, taking into account the level of strategic complementarities κ. Instead, if $\bar{\theta} > r - \frac{\kappa}{2}$, higher uncertainty has a detrimental effect on financial stability and lowers the run threshold. Such a scenario is depicted in Figure 1.7. At $\bar{\theta} = r - \frac{\kappa}{2}$ a change in the uncertainty has no effect on ρ^*.

Regardless of monetary policy uncertainty, at $\rho^* = \bar{\theta}$ the marginal type will expect exactly half of the late investor population to withdraw. Staying with the fund will lead to the same payoff, $r - \kappa\left(1 - \Phi\left(\sqrt{\gamma}\left(\bar{\theta} - \bar{\theta}\right)\right)\right)$ which is equal to $r - \frac{\kappa}{2}$, regardless of β. The expected payoff of withdrawing is denoted by the 45° line from the perspective of the marginal investor with belief ρ^*. If expected monetary policy $\bar{\theta}$ is equal to $r - \frac{\kappa}{2}$ this line crosses the payoff of staying exactly once at $r - \frac{\kappa}{2}$ and uncertainty has no effect on ρ^*.

At the same time at $\rho^* = \bar{\theta}$, there will be the intersection of all functions that describe the payoffs of staying with the fund for any level of monetary policy uncertainty. Hence the effects of uncertainty differ for cases in which this intersection lies to the right of $r - \frac{\kappa}{2}$ compared to cases in which this intersection lies to the left of $r - \frac{\kappa}{2}$. For the case of $\bar{\theta} < r - \frac{\kappa}{2}$, ρ^* will lie to the right of $\bar{\theta}$ and hence the expected payoff of staying will be higher if monetary

[17] To simplify notation I have introduced the parameter γ. When the precision of communication β decreases, the parameter γ increases. This is formally shown in Appendix A.3.

policy uncertainty increases. This increases the running threshold as shown in Figure 1.6. For the case of $\bar{\theta} > r - \frac{\kappa}{2}$ uncertainty decreases the payoff of staying and hence there is decrease in the running threshold ρ^* (Figure 1.7).

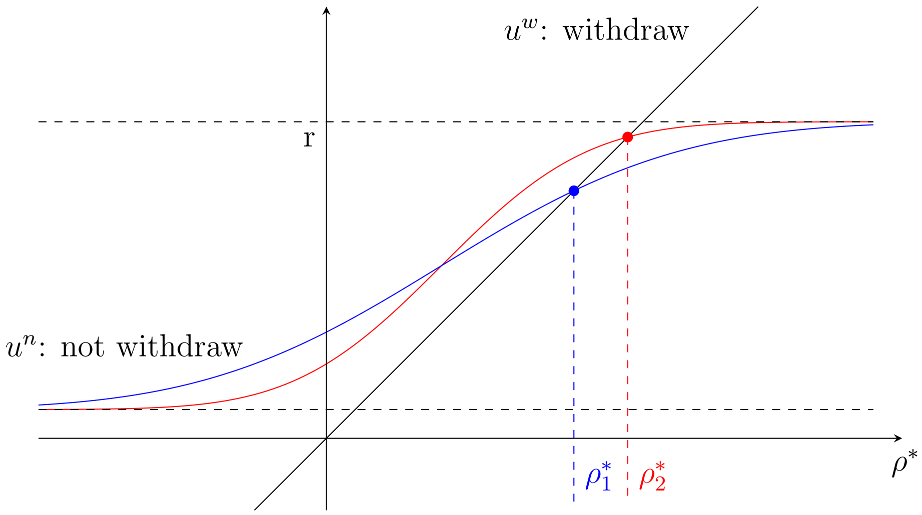


Figure 1.6: Increase in monetary policy uncertainty leads to a higher run threshold in a regime of low interest rates ($\beta_2 < \beta_1$, $\bar{\theta} < r - \frac{\kappa}{2}$)

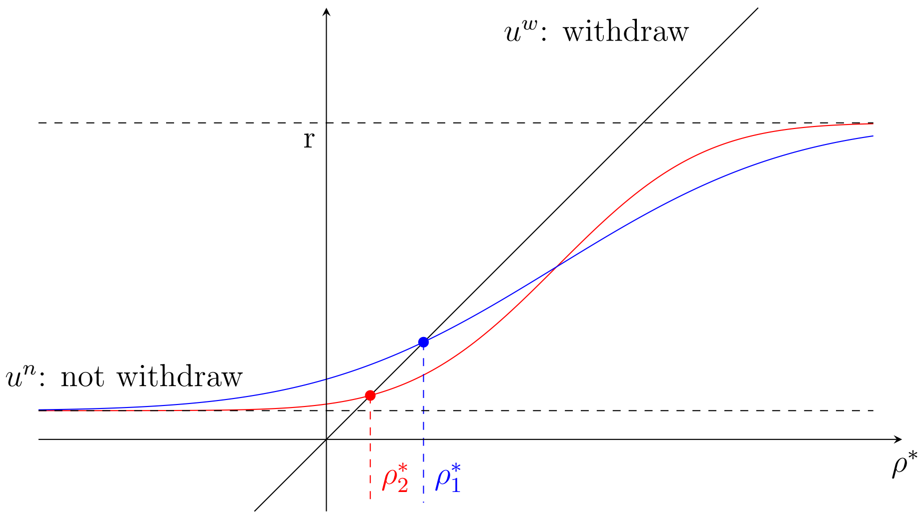


Figure 1.7: Increase in monetary policy uncertainty leads to a lower run threshold in a regime of high interest rates ($\beta_2 < \beta_1$, $\bar{\theta} > r - \frac{\kappa}{2}$)

In order to derive the effects of uncertainty on withdrawals, I first analyze the case without strategic complementarities ($\kappa = 0$). In this case the threshold signal at which an agent decides to run is at $x^*(r, \bar{\theta}) = r + \frac{\alpha}{\beta}(r - \bar{\theta})$. For $\bar{\theta} > r$ the threshold signal will increase if β decreases, for $\bar{\theta} < r$ there will be a decrease in the threshold signal with a decrease in β. Withdrawals $l(\theta) = 1 - \Phi\Big(\sqrt{\beta}\Big(x^*(r, \bar{\theta}) - \theta\Big)\Big)$ depend on whether the realized state θ is larger or smaller than the threshold signal.

For the case with strategic complementarities, additionally I need to take into account the effects of a decrease in β on the run threshold. For the case $\bar{\theta} < r - \frac{\kappa}{2}$, the threshold signal $x^*(\rho*, \bar{\theta}) = \rho^* + \frac{\alpha}{\beta}(\rho^* - \bar{\theta})$ will *increase* for $\rho^* > \bar{\theta}$, partly due to the increase in ρ^* – otherwise the effect additionally depends on α. In the case $\bar{\theta} > r - \frac{\kappa}{2}$, the threshold signal $x^*(\rho^*, \bar{\theta}) = \rho^* + \frac{\alpha}{\beta}(\rho^* - \bar{\theta})$ will *decrease* if $\rho^* < \bar{\theta}$, again in other cases the effects may depends on α. Alternatively one could assume $\beta >> \alpha$ such that comparative statics of the threshold signal are implied by the run threshold. This would mean that private signals are much more precise than the prior expectation.

Even if I assume that comparative statics are pinned down by the effects on the run threshold, withdrawals $l(\theta) = 1 - \Phi\Big(\sqrt{\beta}\Big(x^*(r, \bar{\theta}) - \theta\Big)\Big)$ depend on the realized state θ. Ideally I would compute $E[l(\theta)]$ here. I would need Φ to be a convex function in order to apply Jensen's inequality to derive an upper bound of expected withdrawals.

1.5 Social welfare

Since the effect of changes in the expected future level of monetary policy and monetary policy uncertainty on expected withdrawals are not immediate, I will focus on ex-post social welfare in this section.

In the context of my simple model, defining the first best allocation is straightforward. I need to ensure that the patient investors choose the investment opportunity with the highest consumption levels. Everyone should withdraw if $r < \theta$ and no one should withdraw whenever $r > \theta$. This is reflected by the sharp discontinuity in the blue dotted line in Figure 1.4 that describes the optimal withdrawal behaviour by patient investors. I have verified before, that it always holds that $\rho^* < r$. Since high levels of uncertainty reduce ρ^* for $\bar{\theta} > r - \frac{\kappa}{2}$ one can also ensure that $\rho^* < \bar{\theta}$. This implies that $x^*(\rho^*, \bar{\theta}) = \rho^* + \frac{\alpha}{\beta}(\rho^* - \bar{\theta}) < r$, since the first summand is smaller than r and the second summand is negative. Figure 1.4 depicts such a situation.

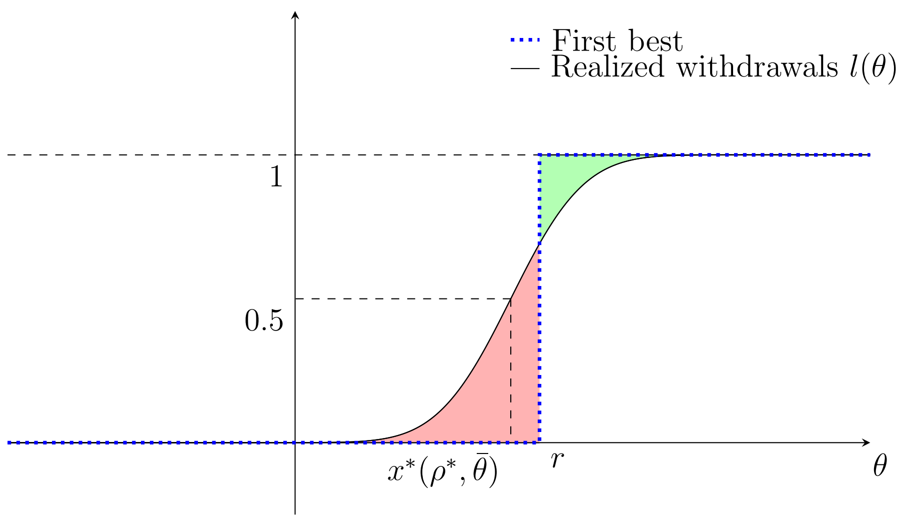


Figure 1.8: Ex-post optimal withdrawal schedule

In the red area below $l(\theta)$ the uncertainty with respect to the true value of θ leads to withdrawal rates that are inefficiently high, while in the blue area above $l(\theta)$ it would actually be optimal if everyone would join the run. In the red area, those that run are disadvantaged due to a low return of the alternative investment, while those that decide to remain in the investor base of the bond fund suffer from the externality caused by those that withdrew their money from the fund. In the green area those that decide to remain in the investor base of the bond fund suffer both from the low returns of the fund (even in absence of a run) and the externalities caused by withdrawals. Changes in monetary policy uncertainty both shift $x^*(\rho^*, \bar{\theta})$ and have an influence on the shape (steepness) of $l(\theta)$. Hence they affect the absolute and relative sizes of the red and green area.

1.6 Empirical implications

This section summarizes the results of the analysis of comparative statics. Most of the previous literature that has looked at uncertainty effects has pointed out a similar shift in the direction of the effects as the one in the $\kappa > 0$-case in Table 1.2.

Table 1.2: Effects on the run threshold ρ^*

Setting	$\kappa > 0$		$\kappa = 0$	
	$\bar{\theta} < r - \frac{\kappa}{2}$	$\bar{\theta} > r - \frac{\kappa}{2}$	$\bar{\theta} < r$	$\bar{\theta} > r$
Increase in prior expectation $\bar{\theta} \uparrow$	lower threshold	lower threshold	no effect	no effect
Increase in MP uncertainty $\beta \downarrow$	higher threshold	lower threshold	no effect	no effect

In order to put into perspective the comparative statics effects derived from a run model with those from a setting without strategic complementarities, one needs to go one step further and analyze the effects on the threshold signal (and the withdrawal schedule). What is often overlooked is that changes in the information structure have an effect even in the absence of strategic complementarities – hence to explain certain effects strategic complementarities are not strictly needed.

Interestingly, in contrast to changes in the mean of the signal, the effects of higher uncertainty on the threshold signal in cases with strategic complementarities ($\kappa > 0$) do not always coincide with the effects in absence of strategic complementarities ($\kappa = 0$). Under the assumption that signals are precise compared to prior uncertainty they will only coincide in the interval $\bar{\theta} \in \left[r - \frac{\kappa}{2}; r\right]$, while the model predicts opposing effects outside these intervals. Strategic uncertainty is the main driver behind this result (see above).

Table 1.3: Effects on the threshold signal x^*

Setting	$\kappa > 0$		$\kappa = 0$	
	$\bar{\theta} < r - \frac{\kappa}{2}$	$\bar{\theta} > r - \frac{\kappa}{2}$	$\bar{\theta} < r$	$\bar{\theta} > r$
Increase in prior expectation $\bar{\theta} \uparrow$	**lower signal**	**lower signal**	lower signal	lower signal
Increase in MP uncertainty $\beta \downarrow$	higher signal*	lower signal**	lower signal	higher signal

* holds if $\rho* > \bar{\theta}$ or alternatively $\beta >> \alpha$, ** holds if $\rho* < \bar{\theta}$ or alternatively $\beta >> \alpha$.

Next, I will try to identify the predictions that are most relevant for the empirical implications of the model. Usually, investors in a portfolio of corporate bonds ask for some return in excess of the expected long-term interest rate, e.g. due to the lower level of liquidity of corporate bonds. Therefore, the scenario $\bar{\theta} > r$ can only occur due to a sudden and sharp reversal of interest rates. In such a case, the expected long-term monetary policy can be above the nominal returns on corporate bonds. Whether the case of $\bar{\theta} < r - \frac{\kappa}{2}$ or the case of $\bar{\theta} > r - \frac{\kappa}{2}$ is empirically relevant should mainly be driven by the degree of strategic complementarities κ that prevail in the market. A relatively low (perceived) κ would make the case for $\bar{\theta} < r - \frac{\kappa}{2}$.

Hypothesis 1. *If investors expect $\kappa = 0$ or $\kappa >> 0$ they should react to higher uncertainty by running at a lower threshold and hence there should be higher withdrawals for a given realization of signals. If they expect the level of strategic complementarities κ to be moderate the model predicts a reduction in outflows for an increase in monetary policy uncertainty.*

For the effects of a level shift in the expected interest rate, the predictions of the model with strategic complementarities and the simple case of $\kappa = 0$ coincide.

Hypothesis 2. *Regardless of the scenario, I expect investors to withdraw from the bond fund if the level of the expected interest rate $\bar{\theta}$ increases.*

The next sections will provide some evidence regarding these predictions.

1.7 Data

Empirically, one of the main challenges is to identify real-world measures that reflect the information structure of the global games setup. Ideally, in addition to providing an "average" signal that corresponds to the prior mean, these measures would reflect the dispersion in private signals.

Midpoint of target range or target level (Percent)	2017	2018	2019	2020	Longer run
...					
1.125	2	1			
1.25					
1.375	14	1	1	1	
1.5					
1.625		1	1		
1.75					
1.875		3			
2					
2.125		6			
2.25					1
2.375		3	2	1	
2.5					2
2.625		1	4	2	
2.75			1		6
2.875			3	1	
3				3	6
3.125			1	5	
3.25					
3.375			2		
3.5				1	
3.625			1		
3.75					
3.875					
4					
4.125				2	

Figure 1.9: FOMC "dot plot" released on 13 December 2017 in scorecard format
Source: Federal Reserve

I will argue that the information provided in the "dot plot", that forms a part of the quarterly-released FOMC projections material[18] enables me to connect the concept of a noisy central bank signal with an empirical counterpart. These "dot plots" aggregate the projections of 15-19[19] FOMC members, each dot representing "an individual participant's judgement of the midpoint of the appropriate target range for the federal funds rate or the appropriate target level for the federal funds rate at the end of the specified calendar year or over the longer run", rounded to the nearest 1/8 percentage point. Via the FOMC's website these projections are available in "scorecard" format (cf. Figure 1.9). The "dot plot" projection information was first published in January 2012. I have obtained the full history of FOMC projections 2012-2017.[20]

[18]The so-called "Economic projections of Federal Reserve Board members and Federal Reserve Bank presidents under their individual assessments of projected appropriate monetary policy".

[19]These projections are voluntary, hence the number of "dots" can vary both across projections horizons and FOMC dates.

[20]The data was obtained from the website of the Federal Reserve through using web-scraping routines.

For each FOMC release I compute the mean projection and its standard deviation in order to explain the flows of mutual funds in the subsequent months (in a robustness check I use the median and the range). Each FOMC date is assigned to the subsequent months.

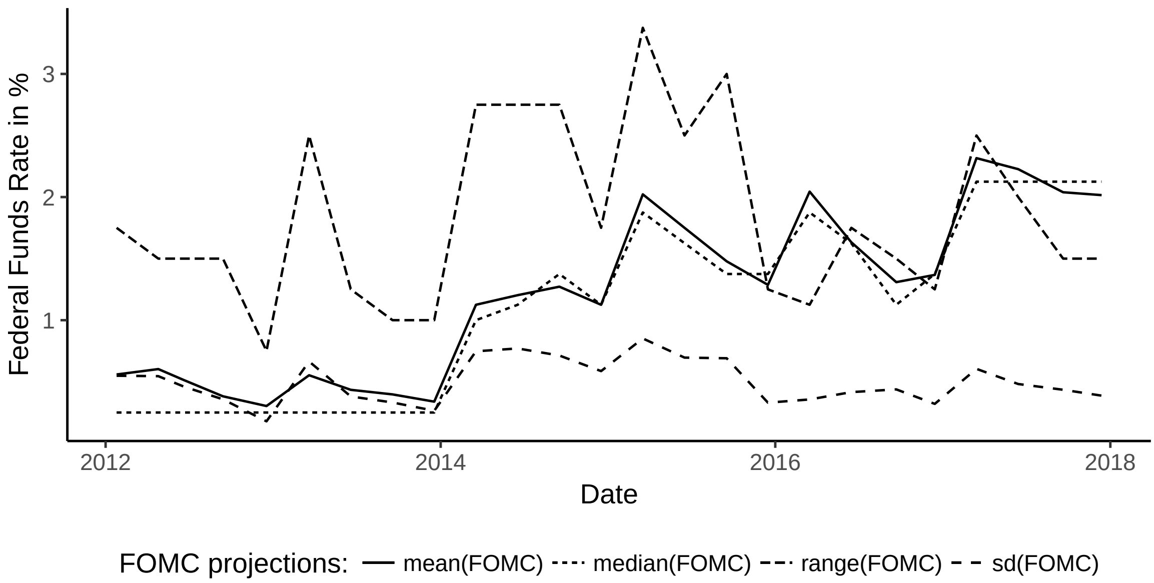


Figure 1.10: Comparison of different forward-looking monetary policy measures 2012-2017
Source: Federal Reserve

The median and the mean projection closely track each other, with the exception of 2012-2014 when the median stayed at zero for a considerable amount of time. Both the standard deviation and the range of the projections show a similar pattern: at first there are fluctuations around a relatively low level of disagreement, then from 2014-2016 there is higher disagreement among FOMC members, while in the more recent past the FOMC projections have become more unanimous, again. My findings are robust regardless of the choice of measures based on the mean/standard deviation or median/range. The strong correspondence between mean and median as well as standard deviation and range is also reflected in the pairwise correlations in Table 1.4.

The "dot plots" published by the Federal Reserve are one of many potential sources of information on the future path of interest rates. Other possible sources are survey measures reflecting the opinions of financial market participants, such as the quarterly "Survey of Professional Forecasters"[21] or measures based on financial market prices. Via the Nelson-Siegel approach one can infer the term structure of interest rates from on the universe of outstanding treasury securities. This approach has been further developed e.g. by Gürkaynak et al. (2007). I compare the FOMC projections information to 1-year treasury forward rates (SVEN1F01) computed with the methodology of Gürkaynak et al. (2007) obtained from

[21] Data is provided via the Philadelphia Fed: `https://www.philadelphiafed.org/research-and-data/real-time-center/survey-of-professional-forecasters/`

the Federal Reserve.[22] While the level of SVEN1F01 is highly correlated with the FOMC projections, the realized volatility of the previous 21 days of SVEN1F01 does not show a strong association with the cross-sectional standard deviation of the FOMC projections.

Table 1.4: Pairwise correlations of monetary policy measures (incl. stock market measures)

	S&P 500	VIX	SVEN1F01	sd()	mean(FOMC)	sd(.)	median(.)	iqr(.)
S&P 500								
VIX	-0.59							
SVEN1F01	-0.09	-0.34						
sd()	-0.02	0.01	0.33					
mean(FOMC)	-0.11	-0.31	0.81	0.23				
sd(.)	-0.09	-0.03	0.16	0.05	0.39			
median(.)	-0.12	-0.31	0.85	0.26	0.99	0.34		
iqr(.)	-0.13	0.01	0.47	0.21	0.59	0.73	0.59	
range(.)	-0.08	-0.11	0.25	-0.01	0.47	0.95	0.44	0.66

Note: The column sd() refers to the 21-day standard deviation of the series SVEN1F01, the columns sd(.), median(.) and iqr(.) refer to measures extracted from the FOMC dot plots.

Additionally, Table 1.4 reports the correlations with monthly returns of the S&P 500 stock market index and the monthly closing price of the VIX index, which captures the stock market's expectation of volatility implied by S&P 500 index options. The correlation of stock market returns and volatility with the forward-looking measures of monetary policy is very limited. Table 1.5 shows summary statistics of all variables included in the analysis that do not vary across funds.

Table 1.5: Summary statistics: monthly variables

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
mean(FOMC)$_t$	69	1.162	0.648	0.303	2.316
sd(FOMC)$_t$	69	0.508	0.181	0.178	0.852
median(FOMC)$_t$	69	1.043	0.687	0.250	2.125
iqr(FOMC)$_t$	69	0.456	0.308	0	1
range(FOMC)$_t$	69	1.870	0.732	0.750	3.375
S&P 500$_t$ (%)	69	0.0101	0.0280	-0.0647	0.0797
VIX$_t$	69	15.39	3.497	9.510	28.43
SVEN1F01$_t$	69	0.828	0.409	0.222	1.634
sd$_{21}$(SVEN1F01)$_t$	69	0.0608	0.0310	0.0135	0.182

The data on mutual fund flows is obtained from the Center for Research in Security Prices (CRSP). The sample period is January 2012 – December 2017 since the "dot plots" were first published by the Federal Reserve in 2012. I select corporate bond funds according to a fund's portfolio share of corporate bonds.[23] If the average percentage of corporate bonds exceeds

[22] Source: `https://www.quandl.com/data/FED/SVEN1F-US-Treasury-One-Year-Forward-Rate-Curve`
[23] Portfolio shares are reported in the quarterly CRSP mutual funds summary dataset.

50%, a fund is classified as a corporate bond fund.[24] In the sample of corporate bond funds I exclude index funds, exchange-traded funds (ETFs) and exchange-traded notes (ETNs). This is in line with the previous literature and excludes funds with limited discretion over which assets are to be sold first. Complementarities should be strongest for funds that remain in the sample. Figure 1.11 shows that during the sample period there have been large inflows and/or valuation gains in the segment of corporate bond funds, leading to an increase in overall assets in my sample from around 500 billion to more than 700 billion US-dollar:

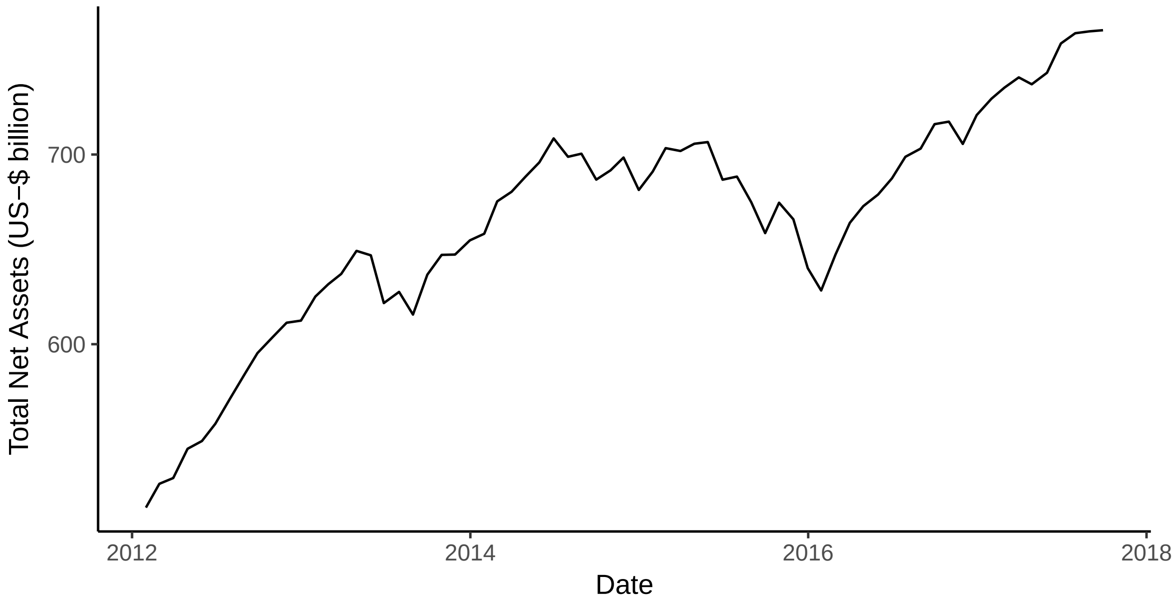


Figure 1.11: Monthly Total Net Assets of corporate bond funds 2012-2017
Source: CRSP

The CRSP mutual fund database reports end-of-month returns ($\text{Return}_{i,t}$) and total net assets ($\text{TNA}_{i,t}$). I apply the following formula in order to obtain monthly fund flows:

$$\text{Flows}_{i,t}\ (\%) = \frac{\text{TNA}_{i,t} - \text{TNA}_{i,t-1}\,(1 + \text{Return}_{i,t})}{\text{TNA}_{t-1}} \cdot 100$$

This approach is standard in the literature using data obtained via the CRSP mutual fund database (see e.g. Chen et al. (2010) or Chen and Qin (2017)). Returns are calculated based on the daily net asset value of the fund and have been adjusted for dividend payments by the data provider.[25] A significant number of investors choose to reinvest fund distributions

[24] In a robustness check I use the selection criterion of Goldstein et al. (2017). The authors use a set of objective codes: (1) Lipper objective code in the set ('A','BBB', 'HY', 'SII', 'SID', 'IID'), or (2) Strategic Insight objective code in the set ('CGN', 'CHQ', 'CHY', 'CIM', 'CMQ', 'CPR', 'CSM'), or (3) Wiesenberger objective code in the set ('CBD', 'CHY'), or (4) 'IC' as the first two characters of the CRSP objective code.

[25] For more details see p. 9 of the CRSP Survivor-Bias-Free US Mutual Fund Database Guide available via WRDS.

automatically instead of receiving them in cash. If investors choose their dividends to be paid in cash they are reported as outflows. However, if investors are rational there should be no difference between these automatic (passive) outflows and other active in- or outflows.

I include only fund shares with an average TNA larger than 5 million US-dollar. The variable Flows$_{i,t}$ (%), which is imputed using the above formula, was trimmed on the fund-level such that flows do not exceed 2500% or fall below -100%.

Constant aggregate inflows are particularly visible in 2012-2014 and 2016-2018 while the period 2014-2016 was characterized predominantly by net outflows. Figure 1.12 shows that during the period that was characterized by higher monetary policy uncertainty, flows have been more volatile overall.

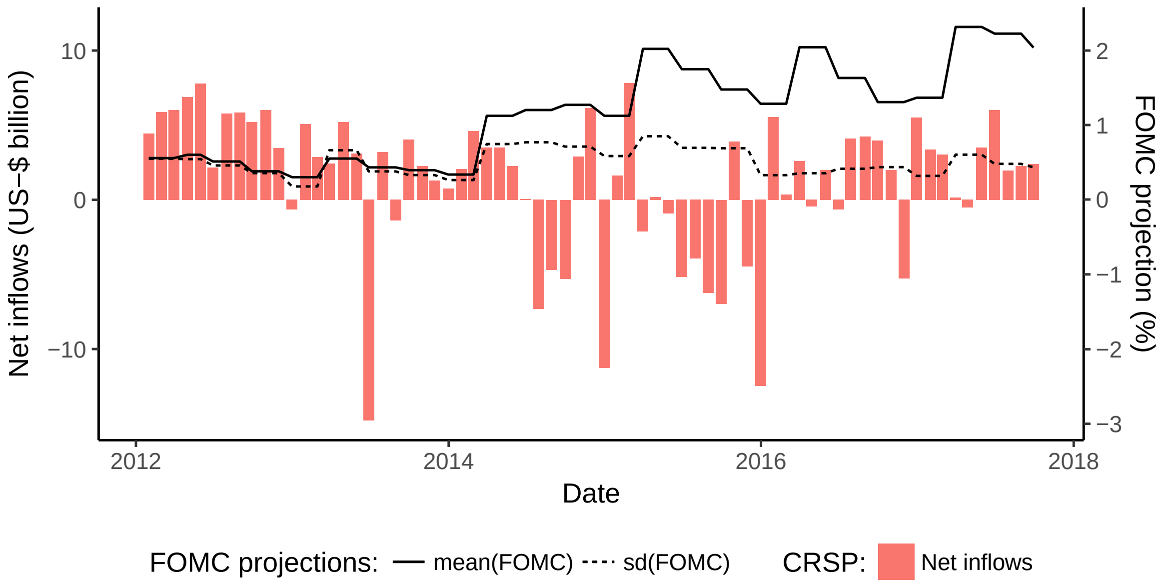


Figure 1.12: Monthly net inflows of corporate bond funds 2012-2017

Source: Federal Reserve, CRSP

The remainder of the empirical analysis will look at the relationship between future monetary policy and fund flows at the level of a single fund. Summary statistics of fund-level variables are reported in Table 1.6.

Table 1.6: Summary statistics: fund-level variables

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
TNA$_{i,t}$	90,026	591.4	1,878	0.100	41,840
Return$_{i,t}$	90,026	0.00383	0.0128	-0.206	0.182
Flows$_{i;t}$ (USD million)	90,026	1.925	91.57	-6,934	8,941
Flows$_{i;t}$ (%)	90,026	2.534	44.84	-99.93	2,500

1.8 Empirical approach

I will test some implications of the theory outlined in the previous sections in a simple fixed-effects panel setup. This approach is similar to Chen et al. (2010) who motivate their hypotheses with respect to the flow-performance relationship in equity funds using a theoretical model based on a global game of fund investors.

I look at the effects of future monetary policy on fund flows. A complicating factor is that – while performance varies across funds – expectations of monetary policy show meaningful variation only over time and across investors. For the latter source of variation, however, data is hard to obtain. This poses challenges for identification. As a first pass, I will estimate the following fixed-effects panel specification:

$$\begin{aligned}\text{Flows}_{i,t}\ (\%) \quad &= \quad \beta_1 \cdot \text{mean(FOMC)}_t + \beta_2 \cdot \text{sd(FOMC)}_t \\ &\quad\; +\beta_3 \cdot \text{Return}_{i,t-1} + \beta_4 \cdot \log(\text{TNA})_{i,t-1} \\ &\quad\; +\gamma \cdot \text{Controls}_t + \mu_i + \varepsilon_{i,t}\end{aligned}$$

I am mainly interested in the regression coefficients of the level (β_1) and the dispersion (β_2) of central bank signals available throughout period t[26] on fund flows. I control for time-constant determinants of flows on the fund level (the fund fixed effect μ_i), as well as the fund's return in the previous period, the log of a fund's total net assets (TNA) in the previous period and some macro control variables, e.g. the monthly return of the S&P 500 and the VIX closing price at the end of the month.

The monetary policy signal is informative with respect to the outside investment option. A fund's portfolio is mostly given and can only marginally change its basic characteristics over the short- to medium-term. This holds especially if one assumes that fund holdings are held to maturity and deliver certain fixed coupon payments.

A higher return on the outside option should therefore lead to outflows from the bond fund. Depending on the degree of strategic complementarities, higher monetary policy uncertainty – or uncertainty with respect to the returns of an investment opportunity that lies outside the fund – can lead to a lower or higher willingness by investors to maintain their fund investment. The effects also depend on the investors' prior mean. My theoretical predictions are summarized in Table 1.3.

For the consistency of my estimators I need all regressors (see equation above) contained in $\boldsymbol{x_{i,t}}$ to fulfil $E(\boldsymbol{x'_{i,s}}\varepsilon_{i,t}) = 0,\ s,t = 1,...,T$. The unobserved effect μ_i is allowed to be arbitrarily correlated with $\boldsymbol{x_{i,t}}$ for all t.

Monetary policy is unlikely to respond to shocks to flows in a particular segment once

[26] For example the information contained in the dot plot released on 13 December 2017 will be assigned to flows in January 2018 and onwards.

we control for some general economic variables such as the returns of the S&P 500 (only the fund-specific shocks would then be captured via $\varepsilon_{i,t}$, not those that are essentially caused by macro variables or shocks to future monetary policy) and some fund specific variables such as lagged fund returns and lagged fund size. It is also unlikely that stock markets (S&P 500, VIX) react to these unexplained withdrawal shocks in bond markets.

The case is harder to make for fund-level variables. For example, I would need both past and future fund returns to be uncorrelated with unexplained withdrawal shocks (i.e. those that are not caused by bad returns or high stock market returns). While the inclusion of the regressors "$\text{Return}_{i,t-1}$" and "$\log(\text{TNA})_{i,t-1}$" should help at ruling out a correlation between $\varepsilon_{i,t}$ and previous values of the fund level regressors, I also need unexplained withdrawal shocks to be uncorrelated with future values of these regressors, e.g. future returns.

There are numerous papers that look at the flow-performance relationship (e.g. Chen et al. (2010) and Goldstein et al. (2017)). The argument is usually, that past performance affects flows (something I take into account). However, I would need unexplained the unexplained component of (past) fund-level flows to have no effect on future performance as well. Given that the effects of withdrawals on future performance are one channel through which mutual funds might exhibit strategic complementarities this assumption is less likely to hold.

The same needs to hold for the correlation between the error term and the future values of total net assets, a stock measure. Shocks to flows in percent of total net assets have to be uncorrelated with past and future values of total net assets. I include this variable since the flows of large funds are usually less responsive to shocks and exhibit smaller flows in percentage terms. However herding behaviour of investors might lead to a correlation between outflows and total net assets on the level of a single fund.

Via the inclusion of interaction terms – e.g. a monthly level of corporate bond fund holdings (currently not available in the CRSP data) – future studies could further explain how the level of strategic complementarities shapes the relationship between monetary policy uncertainty and fund flows. By using data at a higher frequency one could also try to look at the relationship between uncertainty and fund flows in times of market stress. These periods are characterized by particularly low levels of market liquidity which might exacerbate the extent of strategic complementarities.

1.9 Empirical results

The baseline results in Table 1.7 show that there is a negative relationship between the expected level of future monetary policy and corporate bond fund flows. My estimation results are based on fixed effects estimations with standard errors that are clustered on the fund-level (marked with $i/\cdot$ in the last row of the regression tables), on the month-level

($\cdot/t$) as well as using a two-way clustering approach on the fund- and month-level (i/t). An increase by 1 percentage point in the mean FOMC projection for the end of the following year is associated with outflows of 2 % of a fund's total net assets over the course of a month. An increase by 1 percentage point corresponds to an increase by approximately 1.5 standard deviations.

Table 1.7: FOMC projections and fund flows of corporate bond funds

VARIABLES	(1) Flows$_{i;t}$ (%)	(2) Flows$_{i;t}$ (%)	(3) Flows$_{i;t}$ (%)	(4) Flows$_{i;t}$ (%)	(5) Flows$_{i;t}$ (%)
mean(FOMC)$_t$	-1.241***	-2.082***	-2.208***	-2.208***	-2.208***
	(0.268)	(0.313)	(0.340)	(0.309)	(0.379)
sd(FOMC)$_t$	1.135	3.124***	3.350***	3.350***	3.350**
	(0.959)	(1.005)	(1.021)	(1.187)	(1.295)
Return$_{i,t-1}$	22.38*	15.72	11.95	11.95	11.95
	(12.64)	(13.22)	(13.64)	(19.60)	(19.82)
log(TNA)$_{i,t-1}$	-2.167***	-11.94***	-11.95***	-11.95***	-11.95***
	(0.241)	(1.205)	(1.209)	(1.306)	(1.365)
S&P 500$_t$ (%)			8.294	8.294	8.294
			(7.994)	(7.782)	(8.272)
VIX$_t$			-0.0855	-0.0855	-0.0855
			(0.0553)	(0.0630)	(0.0649)
Observations	83,803	83,799	83,799	83,799	83,799
R-squared	0.010	0.076	0.076	0.076	0.076
Fund Fixed Effects	No	Yes	Yes	Yes	Yes
Clustered SE	i/.	i/.	i/.	./t	i/t

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Higher uncertainty – captured by the level of disagreement among FOMC participants – is associated with inflows into corporate bond funds. Hence, investors seem to be more willing to maintain investments in corporate bond funds vis-à-vis other investment options if there is a higher level of disagreement as measured by the standard deviation of the FOMC projections. These findings are robust to the use of alternative measures that capture the distribution of the FOMC projections (cf. Table A.1 in the Appendix).

Using a different sample of corporate bond funds as in Goldstein et al. (2017) also confirms the negative association between the level of future monetary policy and fund flows and the positive relationship with uncertainty measures (cf. Table 1.8).

Using a different measure of expected monetary policy – treasury forward rates captured by the variable SVEN1F01$_t$ – I can confirm the negative relationship between the future level of monetary policy and fund flows. There is also a positive relationship between the realized volatility of forward rates and fund flows, but this relationship is not as robust as the one identified using the standard deviation of FOMC projections (cf. Table A.2 in the Appendix).

Table 1.8: FOMC projections and fund flows of corporate bond funds (Goldstein criteria)

VARIABLES	(1) Flows$_{i;t}$ (%)	(2) Flows$_{i;t}$ (%)	(3) Flows$_{i;t}$ (%)	(4) Flows$_{i;t}$ (%)	(5) Flows$_{i;t}$ (%)
mean(FOMC)$_t$	-0.354	-0.791***	-0.672***	-0.672**	-0.672**
	(0.241)	(0.240)	(0.247)	(0.278)	(0.321)
sd(FOMC)$_t$	1.910***	2.428***	2.285***	2.285***	2.285***
	(0.725)	(0.719)	(0.732)	(0.806)	(0.844)
Return$_{i,t-1}$	46.22***	28.74***	30.20***	30.20**	30.20**
	(11.30)	(10.17)	(10.68)	(14.69)	(15.11)
log(TNA)$_{i,t-1}$	-1.564***	-8.452***	-8.453***	-8.453***	-8.453***
	(0.174)	(0.852)	(0.852)	(0.990)	(0.970)
S&P 500$_t$ (%)			-1.640	-1.640	-1.640
			(6.152)	(7.716)	(7.805)
VIX$_t$			0.0667	0.0667	0.0667
			(0.0485)	(0.0562)	(0.0587)
Observations	89,325	89,322	89,322	89,322	89,322
R-squared	0.008	0.066	0.067	0.067	0.067
Fund Fixed Effects	No	Yes	Yes	Yes	Yes
Clustered SE	i/.	i/.	i/.	./t	i/t

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

1.10 Withdrawal incentives in government bond funds

In the theoretical section I have argued that the effects of uncertainty are largely mitigated by the degree of strategic complementarities investors are facing upon withdrawal. This section will look whether my findings with respect to monetary policy uncertainty prevail in a sample that should be largely free from such effects. The assets of funds in this sample consist of presumably liquid government bonds.

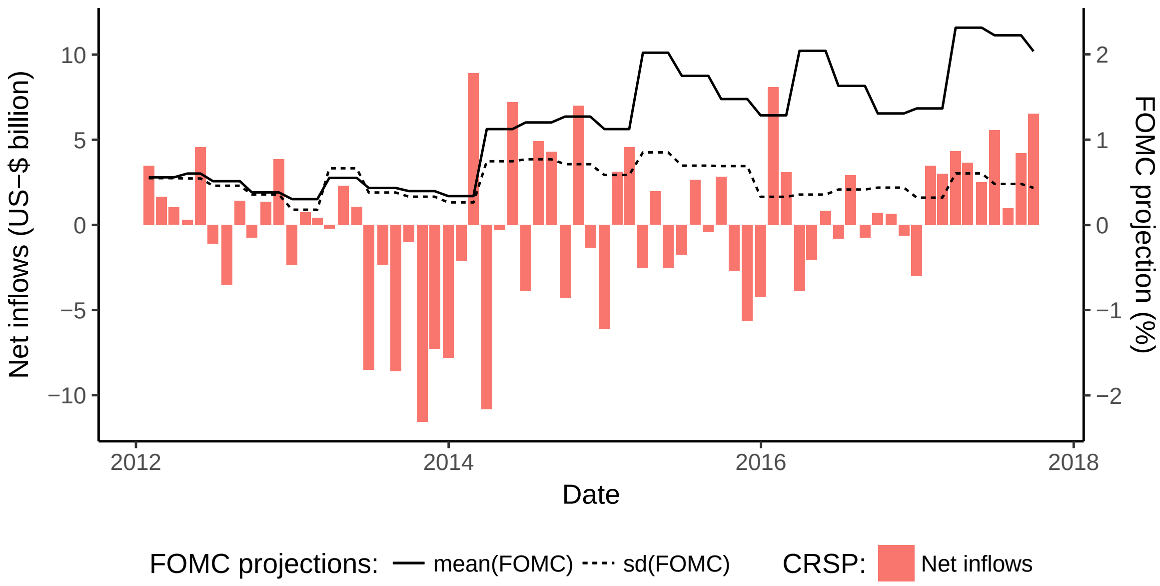


Figure 1.13: Monthly net inflows of government bond funds 2012-2017
Source: Federal Reserve, CRSP

In order to obtain a sample of funds that shows reduced strategic complementarities upon withdrawal I look at funds with an average of more than 75 % of assets invested in government bonds – and include also index funds and ETFs. In these products I expect a lower level of strategic complementarities since assets have to be sold according to index weights and sales of relatively more illiquid assets cannot be postponed. Summary statistics of fund-level variables are reported in Table 1.9.

Table 1.9: Summary statistics: fund-level variables for government bonds

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
$\text{TNA}_{i,t}$	30,174	784.1	2,478	0.100	39,300
$\text{Return}_{i,t}$	30,174	0.000625	0.0270	-0.389	0.433
$\text{Flows}_{i;t}$ (USD million)	30,174	-0.289	127.9	-4,629	5,268
$\text{Flows}_{i;t}$ (%)	30,174	2.119	42.96	-98.60	2,401

Figure 1.13 shows the evolution of fund flows in this sample. These patterns differ from the sample of corporate bond funds.

Table 1.10: FOMC projections and fund flows of government bond funds

VARIABLES	(1) $\text{Flows}_{i;t}$ (%)	(2) $\text{Flows}_{i;t}$ (%)	(3) $\text{Flows}_{i;t}$ (%)	(4) $\text{Flows}_{i;t}$ (%)	(5) $\text{Flows}_{i;t}$ (%)
mean(FOMC)_t	0.296	-2.555***	-2.244***	-2.244***	-2.244***
	(0.504)	(0.573)	(0.603)	(0.514)	(0.564)
sd(FOMC)_t	-2.614**	1.285	1.295	1.295	1.295
	(1.222)	(0.880)	(0.871)	(1.168)	(1.146)
$\text{Return}_{i,t-1}$	17.03	19.24	18.02	18.02**	18.02
	(12.01)	(12.07)	(11.95)	(7.613)	(11.92)
$\log(\text{TNA})_{i,t-1}$	-1.404***	-8.374***	-8.367***	-8.367***	-8.367***
	(0.285)	(1.935)	(1.935)	(1.613)	(1.890)
S&P 500_t (%)			25.63**	25.63**	25.63**
			(10.51)	(10.29)	(10.66)
VIX_t			0.111	0.111	0.111
			(0.105)	(0.0802)	(0.0940)
Observations	30,097	30,097	30,097	30,097	30,097
R-squared	0.006	0.081	0.081	0.081	0.081
Fund Fixed Effects	No	Yes	Yes	Yes	Yes
Clustered SE	i/.	i/.	i/.	./t	i/t

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Indeed, for government bonds, I do not find evidence of a significant positive effect of monetary policy uncertainty in any of our specifications (the pooled regression coefficient is even negative). This points in the direction that strategic complementarities are seemingly less important for these funds (cf. Table 1.10).

1.11 Conclusions

My model describes the role of various theoretical channels through which uncertainty regarding the future level of interest rates affects the redemption behaviour of investors. I distinguish between fundamental uncertainty and strategic uncertainty and show how strategic uncertainty alters the behaviour of fund investors. My main finding connects the direction of the effects of uncertainty to the strength of strategic complementarities among investors. Depending on the degree of strategic complementarities, higher monetary policy uncertainty can lead to a lower or higher willingness by investors to maintain their fund investment. The effects also depend on the investors' prior mean.

I complement these findings with an empirical analysis of the effects of FOMC communications on withdrawals from US-based bond funds. I find that the average prediction of FOMC members with respect to the future level of interest rates is correlated with higher withdrawals. This holds both for funds mainly investing in corporate bond funds and those that mainly invest in government bond funds. A higher level of uncertainty in the predictions of the future level of the interest rate is associated with inflows into corporate bond funds. There is no evidence of such a positive effect on the flows of government bond funds. This is consistent with the model's predictions for a moderate level of strategic complementarities in corporate bond funds ($\kappa > 0$, $\bar{\theta} < r - \frac{\kappa}{2}$). In the absence of strategic complementarities ($\kappa = 0$) increasing uncertainty can have the opposing effects (cf. Table 1.3). This might explain withdrawal patterns from government bond funds.

Overall, this is a first pass on the effects of uncertainty in the communication behaviour of a central bank on financial stability and the behaviour of investors. There is an active discussion in the policy sphere on the existence and the extent of strategic complementarities in corporate bond funds. My analysis shows, that a moderate level of strategic complementarities may explain the differences in the effects of uncertainty on withdrawals between corporate bond funds and government bond funds. While most central banks do not have an explicit financial stability mandate, these considerations might still be taken into account in the design of forward guidance schemes.

Chapter 2

The Portfolio of Euro Area Fund Investors and ECB Monetary Policy Announcements[1]

2.1 Introduction

Since the start of the global financial crisis in 2008, central banks around the world have stimulated the economy by aggressively cutting interest rates and implementing unconventional monetary policies. This paper studies the impact that ECB monetary policy surprises between 2012 and mid-2016 have on the portfolio allocation of euro area fund investors. Our main finding is that these investors are only indirectly affected by monetary policy actions via their impact on asset prices and exchange rates. We find little evidence of investors actively reallocating their portfolios, following significant monetary policy announcements.

Most studies have analysed the transmission of monetary policy via the banking system and financial markets. We want to study whether there is a channel of transmission which goes through the asset allocation behaviour of institutional and retail investors. In particular we look into the class of investment fund investors. From an asset pricing perspective, monetary policy shocks affect investors' behaviour only insofar as they affect the stochastic discount factor and therefore risk premia. A formal analysis of the links between monetary policy and asset allocation would first try to assess how monetary policy shocks affect the statistical joint distribution of the returns of the portfolio asset classes and then derive its implications for the allocation. We bypass altogether the intermediate step of studying the statistical properties of the asset returns and look instead directly at the impact that monetary policy shocks have on allocations.

Central banks can affect investors' behaviour via several channels. One main channel can

[1]This chapter is joint work with Maurizio Michael Habib and Simone Manganelli.

be referred to as the *Signalling Channel*. Changes in monetary policy stance usually affect expectations about future rates, that is the risk neutral components of interest rates. In frictionless finance models, central banks' actions provide new information to investors and affect the forward rates and bond prices, without affecting the positions that arbitrageurs hold in equilibrium and therefore they do not affect risk premia (see, for instance, Bauer and Rudebusch (2014)). As a consequence, the signalling channel should not have an impact on active reallocation (due to actual changes in portfolio shares), but should have an impact on passive reallocation (due to the effects on prices).

A second important channel, which typically goes under the name of *Portfolio Balance Channel*, works through the effect that monetary policy operations have on risk premia. The idea of the *Portfolio Balance Channel* goes back to Tobin (1965) and rests on the key assumption that investors have specific preferences for certain types of financial assets. This may due to differences in preferences, transaction costs or regulatory restrictions. The theoretical implication of this assumption is that changes in the supplies of government bonds to private investors via central bank purchases will affect their prices and yields. For instance, according to preferred habitat models a la Vayanos and Vila (2009) and Greenwood and Vayanos (2014), following surprises in purchases of long term Treasury bonds by the central bank, investors will be forced to hold smaller positions in long term bonds and bear less duration risk, which in turn will lead to a decrease in risk premia and an increase in bond prices. Because of their effect on the stochastic discount factor, monetary policy shocks associated with the portfolio balance channel should have an impact both on the active and on the passive reallocation of investors.[2]

In order to study the impact of ECB policies on the portfolio of euro area investors, we track the evolution of an aggregate portfolio of investment funds that are based in Luxembourg, the largest financial centre for the euro area investment fund industry which mainly attracts euro area investors. We study how investors, on aggregate, choose investment funds at the fund category level, e.g. bond funds versus equity funds, not the portfolio allocation of fund managers. To identify the relevance of the different channels of transmission, we construct measures of *active* portfolio reallocation, driven by the redemptions or injections of underlying investors, and of *passive* portfolio reallocation, triggered by valuation effects related to changes in asset prices and exchange rates, as proposed by Ahmed et al. (2016) and previous work. As common in the literature on the impact of central banks' monetary policy decisions, we identify the announcement effects of traditional and unconventional policies looking at the intraday change in key euro area interest rates around major events, such as ECB Governing Council meetings.

[2] Haldane et al. (2016) provide a broader list of the various channels through which unconventional monetary policies are expected to work, including those channels that are more relevant to our study: policy signalling, portfolio balance, as well as confidence, exchange rate, bank lending and market liquidity premia.

Our main findings show that ECB monetary policy affected investment fund investors mainly via its impact on asset prices and exchange rates. The significant valuation effects associated with these price movements *passively* shifted the asset allocation of euro area investors towards riskier securities, like funds investing in European and Emerging Market equity, and away from European bond funds. These effects are more pronounced for unconventional measures, such as the Asset Purchase Programme (APP). Some *active* reallocation into emerging equity markets following ECB actions is observed for institutional investors. Overall, our daily reallocation measures capture reallocation mostly at the margin – with daily standard deviations between 0.02 and 0.1 percentage points. The lack of active reaction of retail investors is consistent with Calvet et al. (2009) and Ivković and Weisbenner (2009) who find little evidence of a *disposition effect* of past winners for mutual funds. Our findings are also consistent with the growing literature on rational inattention of informationally constrained investors (see for instance Gabaix and Laibson (2001) and Alvarez et al. (2012)). If information is costly to acquire and process, it is optimal to alternate long periods of inaction with brief periods in which information is processed and portfolios are rebalanced.

The paper is structured as follows. In the next section we provide a review of the related literature. Section 3 presents the investment funds data and explains the construction of our measures of active and passive portfolio rebalancing. Furthermore, we introduce the identification strategy for the impact of ECB monetary policy announcements, with a particular focus on major unconventional measures. Section 4 describes the empirical methodology and summarizes our joint estimation approach. Section 5 discusses the main results and Section 6 presents further robustness checks and extensions of the main model. Finally, Section 7 concludes.

2.2 Related literature

Our paper is related to many studies about the impact of standard and non-standard monetary policy measures. Borio and Zabai (2016) provide a review of the flourishing literature on this topic and introduce a useful taxonomy to distinguish *balance sheet policies* aimed at influencing financial conditions beyond the short-term rate, from *forward guidance* that manages expectations regarding the future path of policy rates and *negative interest rate policy.* Overall, they find ample evidence of a significant impact of these policies on financial conditions, but only tentative evidence regarding their impact on output and inflation.

The focus of our paper is more specifically on ECB policies and their immediate impact on financial markets and investors, rather than on their broader impact on the economy. It is therefore closer to studies such as Rogers et al. (2014) who show that ECB monetary policy surprises had a positive impact on stock markets, led to a compression in spreads between core and periphery euro area countries and an appreciation of the euro exchange rate, at least until 2014, the period covered by their study. During this first phase, the *confidence* channel was the predominant channel of transmission, as the ECB promoted financial stability and confidence in the integrity of the eurozone. In addition, Fratzscher et al. (2016a) show that the ECB unconventional monetary polices between 2007 and 2012 had positive financial spill-overs to advanced economies and emerging markets and lowered credit risk among banks and sovereigns in the euro area and other G20 countries. The launch of a quantitative easing programme targeting public sector securities in January 2015, following the introduction of a negative deposit facility rate since mid-2014, characterises a second phase of ECB unconventional monetary policies, where the *signalling* and *portfolio balance* channel take the centre stage and the intended policy objective is the flattening of the yield curve. The early assessment of the APP is generally positive. The launch of the programme persistently reduced long-term sovereign bond yields (Andrade et al., 2016) and the related APP announcements had a price impact that generally increased with maturity and riskiness of assets, with significant spill-overs to non-targeted assets, such as corporate bonds (Altavilla et al., 2015). The APP announcement had international spillovers, boosting equity prices around the world and causing a broad-based depreciation of the euro, but it did not lead to an increase in portfolios flows to emerging market economies (Georgiadis and Gräb, 2016).

Our paper is closely related to a relatively new strand of literature which uses investment funds data to study the impact of monetary policy on portfolio investment decisions, since these data are particularly useful to test the portfolio balance channel of unconventional monetary policies. It is important to note that, over time, the overall portfolio allocation of investment funds is influenced by the behaviour of two types of agents: (i) underlying investors – through injections in and redemptions from funds – and (ii) asset managers. Similarly to several other papers, we identify the changes in asset allocation driven *only* by underlying investors, not by asset managers, because flow data allow a cleaner identification of short-term shifts in asset allocation – since flows are available at a daily frequency, whereas detailed asset allocation data are only available at a monthly frequency. Moreover, as noted by Raddatz and Schmukler (2012), over the short-run managers usually allow shocks to returns to pass-through to country weights. Table 2.1 summarises the main findings of this empirical literature, clarifying how conventional or unconventional monetary policies have been identified. Overall, the existing evidence suggests that monetary policy easing by major central banks is associated with a shift towards riskier assets, even though these are not necessarily domestic equity securities, but may include foreign securities. Specifically, positive monetary policy surprises, i.e. those associated with an unexpected easing of monetary policy, lead to a rotation of the portfolio towards developed market equity by asset managers (Cenedese et al., 2015) or by underlying investors (Curcuru et al., 2015). Similarly, Hau and Lai (2016) show that loose monetary policies in the euro area are associated with a shift out of money market funds towards equity. However, Banegas et al. (2016) and Kroencke et al. (2015) find the opposite result in the case of US Fed monetary policy shocks. Indeed, Fratzscher et al. (2016b) show that US Fed QE1 and QE2 had opposite effects on flows to US equity, suggesting that it is important to distinguish carefully the type of monetary shock. The evidence of spill-over of an expansionary domestic monetary policy to foreign securities is more coherent and convincing. Notably, with the exception of US Fed QE1 (Fratzscher et al., 2016b), monetary policy easing by the Fed prompts a rebalancing of portfolio towards non-US equity ((Cenedese et al., 2015; Fratzscher et al., 2016b; Kroencke et al., 2015)). Similarly, unconventional ECB monetary policies – until 2012 – led to larger flows to emerging market bond and equity funds and developed market bond funds (Fratzscher et al., 2016a).

Papers that include more detailed information regarding the asset allocation of specific investors – such as Joyce et al. (2014) for UK-based institutional investors or Bua and Dunne (2017) for Irish investment funds – find evidence of rebalancing from government bonds, the primary targets of the Bank of England or ECB operations, towards corporate bonds or closer substitutes, such as foreign government bonds. In particular, Bua and Dunne (2017) stress that the portfolio balance channel of the ECB's public sector asset purchase programme operated through purchases of foreign assets, in particular by funds not holding euro area government bonds and not directly exposed to the ECB APP. At the same time, Koijen et al. (2016) and the report by the Bundesbank (2017) confirm the important role of foreign investors as the main counterpart of ECB APP operations.

Finally, since we distinguish active rebalancing by fund investors from passive return effects, the results in our paper can be related to the ample literature on the behaviour of individual investors chasing returns or selling past winners, surveyed by Barber and Odean (2013) and, in particular as regards fund investors, by Levy and Lieberman (2015).

Our paper contributes to this literature in several different ways. First, it is the only study zooming in on ECB policies and portfolio decisions of euro area investors, together with Fratzscher et al. (2016a). Compared to the latter study, which covers ECB policies until 2012, we extend the sample to mid-2016, including in particular the Asset Purchase Programme. In addition, we construct our measures of ECB monetary policy surprises, based on the impact of announcements on euro area short-term and long-term interest rates. Similarly to the most recent studies using investment funds data,[3] we analyse proper portfolio shifts, not just flows, through the measure of active reallocation. Compared to the other studies, to our knowledge, this is the first paper using daily data to identify the contribution of each component – active versus passive – to the total reallocation of a broad

[3] Ahmed et al. (2016) is a recent example, but also Grinblatt et al. (1995) or Curcuru et al. (2011).

portfolio, in particular highlighting the contribution of a proxy of the passive exchange rate component against the passive return effect.

The next two sections explain our identification of monetary policy surprises and the construction of active and passive reallocation measures, respectively.

Table 2.1: Survey of empirical evidence

Study	**Data**	**Identification**	**Main findings**
Banegas et al. (2016)	ICI fund flows, US-based funds, monthly (2000-14)	Deviation of Fed fund rate from Taylor rule based on survey data	Unexpected Fed tightening (shock to the path of monetary policy) associated with outflows from bond and inflows to equity mutual funds
Bua and Dunne (2017)	Portfolio holdings, Ireland-based funds, quarterly (2014-2016)	QE dummy variables for different time periods	QE leads to rebalancing by fund managers from EU government bonds (targeted by CB operations) towards corporate bonds or closer substitutes, such as foreign government bonds
Cenedese et al. (2015)	EPFR country flows, global funds, monthly (2008-14)	Intraday change in US long-term yields and actual US Fed operations	US unconventional monetary policies prompt rebalancing of fund managers to non-US securities, in particular DM equity, and away from US securities
Curcuru et al. (2015)	EPFR fund flows, global funds, daily (2007-14)	Intraday change in long-term yields (US/UK/JP) or spreads (EA)	Active reallocation of underlying investors to DM equity and out of DM bonds following Fed and ECB easing
Fratzscher et al. (2016b)	EPFR fund and country flows, global and US-based funds, daily (2007-10)	Event dummy and actual US Fed operations	US Fed QE1 in 2008 triggered a portfolio rebalancing by underlying investors into US equity and bond funds and out of EM funds. US Fed QE2 since 2010 had the opposite effect
Fratzscher et al. (2016a)	EPFR fund and country flows, global and EA-based funds, daily (2007-12)	Event dummy and actual ECB operations	Some evidence of stronger inflows by underlying investors into EA periphery equity and, in some cases, bond markets, partly rebalancing from highly-rated EA countries. Positive impact on flows to EM equity and bond funds and DM bond funds
Hau and Lai (2016)	LIPPER fund flows, EA-based funds, quarterly (2003-10)	Change in real interest rates across EA countries	Loose monetary policy associated with an increase in inflows by underlying investors into equity and outflows from money market funds
Kroencke et al. (2015)	EPFR fund flows, US-based funds, weekly (2006-2014)	Weekly changes in US 2-year and 10-year Treasury yields	Fed easing associated with reallocation by underlying investors to non-US assets. Yield curve flattening associated with a shift out of equities and into US bonds
Joyce et al. (2014)	Micro dataset of UK-based institutional investors, quarterly (1985-2012)	Actual BoE operations	Reallocation of fund managers from UK gilts to corporate bonds following BoE quantitative easing

2.3 Data

This section presents the investment fund data and explains the construction of our portfolio of euro area investors. In particular, it introduces the concepts of *active* and *passive* reallocation that shall be used throughout the rest of the paper as main dependent variables. We also explain how monetary policy shocks are identified.

2.3.1 Investment funds data and Luxembourg-based funds

Our sample is daily and runs from 1 January 2012 to 30 June 2016. We downloaded data for investment funds based in Luxembourg from the EPFR database. This dataset has been extensively used in the recent literature on the impact of monetary policy (cf. previous section), but it has also been used to study the impact of funding shocks on emerging markets asset prices (Jotikasthira et al., 2012) and to analyse capital flows to emerging markets (Fratzscher, 2012).

In the EPFR dataset, new funds are continuously added, while other funds might drop out of the sample, creating structural breaks in our series on a daily basis. For this reason, we fix our fund universe as of the 1st of January 2012 in order to eliminate any *entry* bias in our sample and we control for the possible exit of funds through internal consistency checks.[4]

The coverage by EPFR of investment funds domiciled in other euro area countries is increasing over time, but still relatively low, and this led to the decision to focus on Luxembourg-based funds. This decision, however, is not only driven by data availability but also justified by the fact that Luxembourg is the most important financial centre for the euro area investment fund industry. This is a large industry with EUR 10.6 trillion assets under management (AuM) for equity and bond funds (including funds of funds and excluding money market funds) as of the second quarter of 2016, of which around one third, EUR 3.7 trillion are located in Luxembourg.[5] Crucially, euro area investors account for the bulk of cross-border equity investment in Luxembourg, 72% of the total stock of derived Luxembourg equity liabilities according to the IMF CPIS dataset.[6] Therefore, we may claim that Luxembourg-based funds are broadly representative of an average euro area investor.[7]

[4]Following Kroencke et al. (2015), it is possible to reconstruct an internally consistent series of TNA and identify these potential structural breaks. We find major inconsistencies – larger than 1% of fund category TNA - for 52 fund category-day combinations out of 9,328 and include a dummy variable in our regressions to control for these breaks. Moreover, we double check the results with a different sample, fixing the universe as of the 1st of January 2014.

[5]The industry is highly concentrated in a few countries of the euro area. The four largest domiciles by assets under management (Luxembourg, Germany, Ireland and France) account for more than 80% of total AuM between 2010 and mid-2016.

[6]See also Figure B.3. In balance of payments statistics, the purchase of a share of an investment fund based in Luxembourg by a non-resident is recorded under portfolio equity investment liability.

[7]However, it should be noted that Floreani and Habib (2015) show that the investors from peripheral euro

We considered the inclusion of funds based in Ireland, another important financial centre within the euro area. However, the foreign investor base of Ireland is much more geographically diversified with respect to that of Luxembourg. In particular, euro area investors account for only 30% of Irish cross-border equity liabilities. Therefore, we may not claim that Irish funds represent the behaviour of an average euro area investor and decided to focus our analysis on Luxembourg-based funds.

2.3.2 The construction of the aggregated portfolio

Funds are classified in the EPFR database according to their main mandate by asset class – equities or bonds – in a specific geographic area – Western Europe (WE), US and Asia Pacific including Japan (USAPJ), Global (GLOB) or Emerging Markets (EM).[8] We create an *aggregate portfolio* composed by the assets held by these eight different fund categories and, as explained in the next sub-section, we shall study the reallocation of fund investors across these major categories.

The size and composition of this *aggregate portfolio* is shown in Table 2.2. As regards the size of the Total Net Assets (TNA) under management, the coverage of the whole universe of Luxembourg-based funds is significant. On average between 2012 and mid-2016, total net assets of Luxembourg-based funds amounted to EUR 554 billion in our dataset; this corresponds to 27% of the total universe of equity and bond funds, as reported by the ECB (almost EUR 2.1 trillion). As regards the composition of our aggregate portfolio between equity and bonds, the EPFR coverage is higher for equity funds (36%) than for bond funds (19%), resulting in a portfolio tilted towards risky assets (60% of the total portfolio) and, in particular, emerging market equities (21% of the total portfolio). The lower coverage for bond funds is a disadvantage in our case, as we could miss the activity of the funds that were most affected by ECB APP purchases. Moreover, the EPFR dataset does not provide a breakdown for funds investing only in the euro area. However, the available aggregation allows to study fund flows at a daily frequency, a distinct advantage compared to several other studies using fund data, since it allows a clean identification of the monetary policy shock and its impact.

area countries are generally overexposed to euro area financial centres, such as Luxembourg and Ireland, compared to investors from core euro area economies and according to an international gravity model.

[8]We generate the category USAPJ ourselves, by aggregating data on North America and Asia Pacific Japan from EPFR.

[9]For USAPJ bonds, the currency allocation reflects only US bond funds since EPFR does not provide currency information on APJ Bonds. The country allocation is based on the monthly country allocation dataset of EPFR. The coverage of this dataset is more limited, the average TNA of Emerging market funds in the country allocation dataset is 49% of the total TNA of the flow dataset, which we use for the remainder of our analysis. However, coverage is generally lower for bonds than for equities and, e.g. coverage of the TNA of Global funds from the flow dataset is in the single digits in the allocation dataset. The category USAPJ is entirely missing from the allocation dataset. We aggregate funds with suitable mandates from Thomson Reuters Lipper for IM (e.g. United States, ASEAN, Korea, Japan) in order to extrapolate the

Table 2.2: EPFR portfolio, Jan 2012 - Jun 2016 averages

	Equity				Bonds				*Total*
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM	
EPFR Portfolio									
TNA (EUR bn)	87.3	67.5	64.2	113.9	58.7	17.7	93.1	51.2	*553.6*
% of TNA in total portfolio	16%	12%	12%	21%	11%	3%	17%	9%	*100%*
Currency denomination of funds (% of TNA within each fund category)									
EUR	92%	17%	38%	14%	92%	12%	43%	23%	*43%*
USD	3%	67%	60%	83%	0%	83%	46%	73%	*50%*
Other	5%	17%	2%	2%	8%	5%	11%	4%	*7%*
Total	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Country allocation of funds (% of TNA within each fund category)									
EA	62%	2%	13%	1%	83%	5%	29%	0%	*26%*
US	0%	67%	46%	0%	1%	73%	34%	0%	*22%*
Other	38%	32%	42%	99%	16%	22%	37%	100%	*53%*
Total	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*

Note: See also footnote [9]

EPFR provides daily data on returns ($R_{i,t}$), the Total Net Assets ($A_{i,t}$), and flows ($f_{i,t}$) into our eight different categories of funds (i), e.g. Luxembourg-based funds investing in Western European equities (see upper panel of Table 2.4 for summary statistics). The original data are collected in the currency denomination of the fund and transformed by EPFR into US dollars. Therefore, the dataset includes an additional term ($fx_{i,t}$) to account for changes in the valuation of non-US dollar denominated fund shares. Flows are derived from the changes in a fund's Total Net Assets and the daily returns at the level of fund shares. Flows, assets and returns are then aggregated into the eight broad categories, which form our portfolio. Flows and assets are summed up across all funds in a given category, whereas the aggregate return for the asset class i ($R_{i,t}$) is the weighted average of the returns of each single fund in that category, where the weights are the assets of each fund divided by Total Net Assets in category i.

Applying the same methodology as EPFR, we convert our portfolio into euro, using the end-of-day exchange rates from Datastream[10] (Ticker: USEURSP) for Total Net Assets $A_{i,t}$ and the average exchange rate between the two days for flows ($f_{i,t}$), obtaining a valuation adjustment term in euro, $fx_{i,t}$[11], which accounts for the currency impact of fund shares denominated in a currency different from the euro. It is important to note that this term

country holdings for this category. For the totals we multiply the percentages from the country/currency allocation table with the TNA of the EPFR flow dataset.

[10]The provider of the mutual fund database (EPFR) uses foreign exchange quotes from XE.com Inc., a commercial provider of FX information. Since all TNAs and flows are reported by Luxembourg-based funds with respect to the same market close, we apply the same conversion factor to all asset classes, and then focus our analysis on the differential effects between asset classes, small mismatches between the two data providers should not be consequential for our estimation. Quoting all results in Euro, however, makes the interpretation of the effects a lot easier. Our daily closing spot rates are quotes that are fixed at 4 p.m. UK time which ensures that there is no overlap with our event windows. See also https://financial.thomsonreuters.com/content/dam/openweb/documents/pdf/financial/wm-reuters-methodology.pdf

does not reflect the actual exchange rate exposure of the funds, whose impact is included in the return ($R_{i,t}$) if the fund has a foreign (non-euro) currency exposure, but it is denominated in euro. A simple example may clarify this point. In general, funds domiciled in Luxembourg with a mandate to invest only in US stocks may be denominated in US dollar – usually to target global investors, or in euro – to appeal to euro area investors. Assume that the daily return of the US stock market is equal to zero, but the dollar appreciates by 1% against the euro. In our dataset, the USD-denominated fund will correctly report a flat daily return and an increase in valuation by 1% in the exchange rate term. Nevertheless, the EUR-denominated fund will report a daily return by 1%, driven by the valuation effect, and a zero contribution by our *fx* term. Therefore, the closer the denomination of funds to the actual currency exposure, the better our *fx* term will capture the true valuation effect related to exchange rate movements. Fortunately, comparing the middle and lower panel of Table 2.4, it is possible to note a relatively broad correspondence between the currency denomination of funds and their country allocation in particular for WE and USAPJ equity and bond funds, and partly also for GLOB bond funds. Moreover, in the case of EM bond funds, the country asset allocation does not reflect the currency exposure, as this market segment is dominated by US dollar issuance and, only recently, domestic currency issuance started to take place. Therefore, also for this asset class the currency denomination of funds may offer a good indication of the direction of exchange-related valuation effects in our broad portfolio.

2.3.3 Measures of active and passive reallocation

For our empirical exercise we take as a starting point the euro-based portfolio weight of fund category i (we look at $N = 8$ fund categories) at time t:

$$w_{i,t} = \frac{A_{i,t}}{\sum_{i=1}^{N} A_{i,t}}.$$

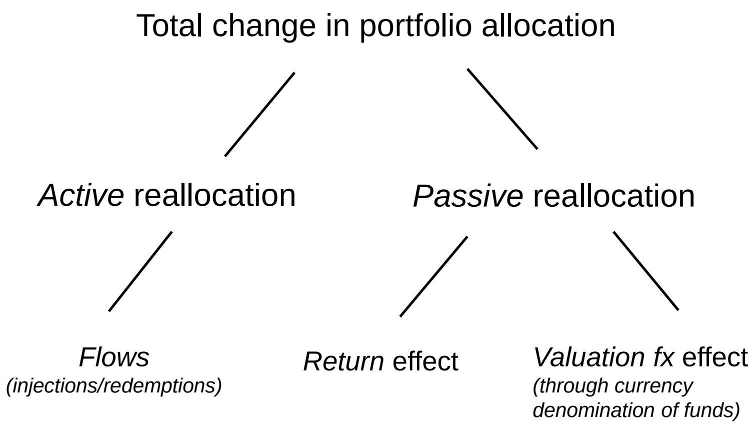
where $A_{i,t}$ denotes the amount of assets under management in euro for all funds of category i at time t. This measure enables us to answer the following question: how do unexpected changes in the monetary policy of the ECB affect the global investment portfolio of fund investors in Luxembourg?

The sum of the end-of-day portfolio weights is 1 at any point in time. However, a change in the portfolio weight $\Delta w_{i,t} = w_{i,t} - w_{i,t-1}$ can be due to valuation effects (*passive* rebalancing) or inflows/outflows (*active* reallocation). Figure 2.1 illustrates these terms, which we use throughout the paper.

[11] If there are inconsistencies in the data reported by EPFR, e.g. a drop in overall AuM due to a fund dropping out of the sample, this will also be asorbed by $fx_{i,t}$.

What matters for portfolio weights are the changes in category i relative to the other fund categories. This is why focusing exclusively on fund flows will only reveal a partial answer to our question regarding active reallocation: for example there might be simultaneous outflows from all fund categories without an effect on the individual portfolio weights.[12] At the same time, there might be positive returns in all asset classes; however, the weight of the asset class with the highest return will increase at the expense of the weight of the asset class with the lowest return.

Figure 2.1: Decomposition of portfolio changes



We extend the measures proposed by Grinblatt et al. (1995) and Curcuru et al. (2011), incorporating the FX term from the EPFR dataset. These measures are based on the following identity:

$$A_{i,t} = A_{i,t-1}R_{i,t} + f_{i,t} + fx_{i,t}$$

Total Net Assets $A_{i,t}$ of fund category i at the end of period t, can be expressed as the combination of the assets at the end of the previous period $A_{i,t-1}$ multiplied by the gross returns over this period $R_{i,t} = 1 + r_{i,t}$, inflows/redemptions by investors $f_{i,t}$, and currency valuation effects $fx_{i,t}$ due to changes in the value of the denomination currency of fund shares vis-à-vis the reporting currency. In our final dataset all these measures are in euro terms, including the FX effect of the currency denomination of the funds, as explained in Section 3.1.

Our goal is a decomposition of the changes in the portfolio weights due to passive reallocation (driven by changes in returns and exchange rates) and active reallocation (due to new inflows and outflows of funds). We take as a starting point the decomposition of Ahmed

[12]This would happen if some investors convert fund shares in cash proportional to their ex-ante portfolio weights.

et al. (2016), which we extend by accounting for an additional FX term that captures passive changes in the portfolio due to exchange rate movements.

$$\begin{aligned}\Delta\text{Portfolio Share} &= \Delta\text{Passive reallocation (returns)}\\ &+ \Delta\text{Passive reallocation (FX)}\\ &+ \Delta\text{Active reallocation (flows)}.\end{aligned}$$

According to this decomposition, it is possible to isolate the change in the portfolio that is simply driven by differential changes in asset prices across the different categories in our portfolio. In particular, to obtain the passive realloaction due to differential returns, one should compare the new portfolio weight of category i abstracting from flows and FX effects with the portfolio weight from the previous period:

$$\begin{aligned}\Delta\text{Passive realloction (returns)} &= \frac{A_{i,t-1}R_{i,t}}{\sum_{j=1}^{N} A_{j,t-1}\cdot R_{j,t}} - \frac{A_{i,t-1}}{\sum_{j=1}^{N} A_{j,t-1}}\\ &= w_{i,t-1}\cdot\left(\frac{R_{i,t}}{R_{P,t}}-1\right)\end{aligned}$$

where $R_{i,t}$ denotes the returns of the portofolio between period $t-1$ and period t and the portfolio return is computed as $R_{P,t}=\sum_{j=1}^{N} w_{j,t-1}\cdot R_{j,t}$. In a similar fashion, one can compute the passive change in the weight of fund shares denominated in a currency different from the euro that is triggered by exchange rate changes:[13]

$$\begin{aligned}\Delta\text{Passive realloction (FX)} &= \frac{A_{i,t-1}+fx_{i,t}}{\sum_{j=1}^{N}\left(A_{j,t-1}+fx_{j,t}\right)} - \frac{A_{i,t-1}}{\sum_{j=1}^{N} A_{j,t-1}}\\ &= w_{i,t-1}\cdot\left(\frac{R^f_{i,t}}{R^f_{P,t}}-1\right)\end{aligned}$$

Here we use the FX return $R^f_{i,t}=1+\frac{fx_{i,t}}{A_{i,t}}$ and the average FX return across all fund categories $R^f_{P,t}=\sum_{j=1}^{N} w_{j,t-1}\cdot R^f_{j,t}$. As in Ahmed et al. (2016) the active reallocation, the part of the decomposition that is driven by inflows and outflows of investors, can be computed as the part of the shift in portfolio weights not due to returns or FX effects.

$$\Delta\text{Active reallocation} = w_{i,t} - w_{i,t-1}\cdot\left(\frac{R^f_{i,t}}{R^f_{P,t}}-1\right) - w_{i,t-1}\cdot\left(\frac{R_{i,t}}{R_{P,t}}-1\right) - w_{i,t-1}$$

[13]As discussed in Section 3.1, EPFR data do not allow us to look at the true currency exposure of the fund portfolio, but only a proxy through their currency denomination.

But one can also show the equivalence to:

$$\Delta\text{Active reallocation} \quad = \quad \frac{A_{i,t}}{\sum_{j=1}^{N} A_{j,t}} - \left(\frac{A_{i,t} - f_{i,t}}{\sum_{j=1}^{N} A_{j,t} - f_{j,t}} \right)$$

This captures the *active* reallocation component of the underlying fund flows $f_{i,t}$ that induces an actual change in the asset allocation. Active changes in the portfolio weight of a certain fund category should be able to capture quite well the intentions of investors to increase the exposure towards this specific asset class and geographic focus.

The value of this measure will be 0 both in the absence of flows, and in the case of inflows/redemptions that affect every fund category in the same manner. It is measured on the same scale as the portfolio weight $w_{i,t}$ which is strictly between 0 and 1. However, for the purpose of our empirical analysis we multiply it by 100 to capture the active reallocation in percentage points based on portfolio weights between 0% and 100% of the total portfolio.

Finally, we want to stress again two important properties of our reallocation measures that are both implied by the fact that we provide a decomposition of portfolio shifts. First, across the $N = 8$ fund categories all reallocation measures mechanically sum up to 0. We exploit this in our estimation approach, by imposing an additional restriction on the fitted values. Second, the sum of the active reallocation measure and the two passive reallocation measures will indicate the total reallocation, i.e. the total shift in portfolio weights between period $t-1$ and period t.

Table 2.4 includes summary statistics for all our reallocation measures for the aggregate portfolio, while Tables B.4 and B.5 in the Appendix provides detailed statistics for each fund category. It is important to note that on a daily basis the volatility of these measures is very low, ranging from 0.02 percentage points for the *active* reallocation measure to around 0.1 percentage points for the *total* reallocation measure. This is not surprising and consistent with the findings of Bacchetta and van Wincoop (2017) who suggest that portfolio decisions are "infrequent" (at most once in 15 months). Therefore, aggregating all investors, the adjustment of the total portfolio can only be at the margin. The interesting question we tackle in this paper is whether ECB monetary policy surprises drive these marginal adjustments for euro area investors, similarly to one of the main findings of Ahmed et al. (2016) showing that active reallocations into emerging market equities by US investors, at a low frequency, appear to be mainly driven by the level of US long-term interest rates.

2.3.4 ECB unconventional monetary policies and identification strategy

Our sample period starts at the beginning of 2012 and ends in June 2016. Our focus is on the second phase of unconventional measures that were implemented by the ECB, targeting in particular the European sovereign debt market, including the OMT programme and the APP programme. Monetary policy surprises are calculated using an approach similar to Rogers et al. (2014). The surprises (Δi_t^{EA}) are based on changes in short-term interest rates and long-term government bond yields for the euro area on the days of announcements of ECB monetary policy decisions. We use quoted bid prices from the Thomson Reuters Tick History Database within a 2-hour window around important ECB announcements – all Governing Council meetings and other events, as identified by Rogers et al. (2014), Curcuru et al. (2015) and Altavilla et al. (2015) – and select the first and last available observation within each time window.[14]

We extract changes in the weekly, the monthly and the 3-month EONIA OIS and average them to obtain our monetary policy surprise to euro area short-term rates. However, as regards long-term rates, the choice of the benchmark for the euro area is not straightforward. One candidate could be the Bund-yield, but, as noted by Rogers et al. (2014), price changes in Bund prices may be driven by safe-haven motives, in particular at the peak of the euro area crisis in 2012, rather than by changes in the expected future path of long-term interest rates. A positive surprise that removes uncertainty in the market and reduces risk premia would lead to an increase in equity market valuations, but it might lead to a decrease in Bund prices, since holdings of safe haven asset become less attractive. At the same time, if the markets were expecting more expansionary measures than those that were announced during during a particular ECB announcement – a negative surprise – Bund yields could decrease on the back of higher demand for safe haven assets. Therefore, in order to identify a positive surprise, i.e. a loosening of the monetary policy, we use the *inverse* of the (unweighted) average change[15] in the 10-year sovereign bond yields of Germany, Italy and Spain, so that a decline in the average yield would correspond to a monetary policy easing. This approach bears some similarities to Rogers et al. (2014) who use the spread between German and Italian bonds for the identification of monetary policy surprises in the euro area. Our approach has the advantage that we would identify both a decrease in sovereign risk through a tightening of the spreads and a simultaneous decrease in all three rates as a positive monetary policy surprise, for instance an easing announcement such as the launch of the APP that shifted the yield curve downward. At the same time by relying on three instruments we can decrease the amount of noise in the small surprises, since we will only identify a clear positive surprise related to the portfolio balance channel if all three rates move in the same direction. The interpretation is straightforward. All coefficients

[14]We use intraday 1-minute data provided by Thomson Reuters Tick History. The last bid price before the event window might come from a quote from some earlier one-minute window. Yields are re-matched from tick data and identified by the (median yield of) RIC-day-bid price-combinations.

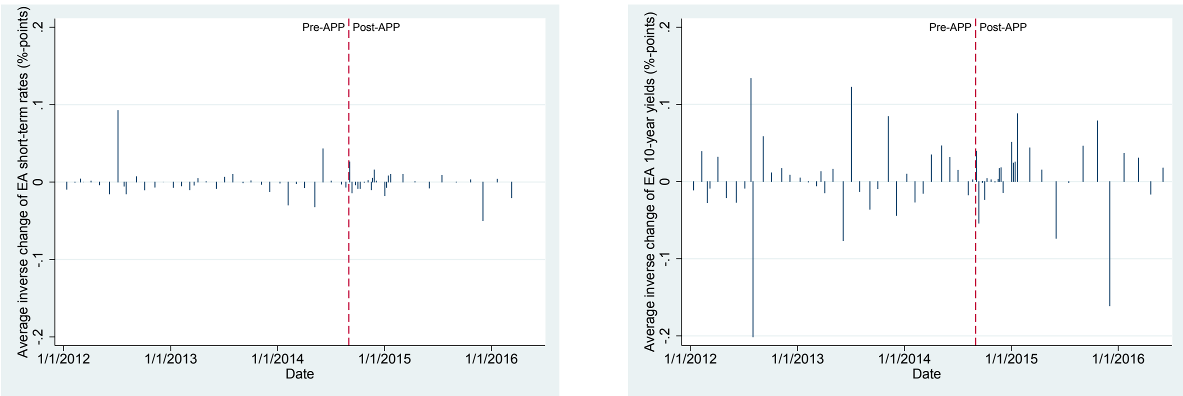
[15]Results with monetary policy surprises that are weighted by outstanding volume of debt securities issued by the general government or the GDP of each of the three countries do not differ markedly from the unweighted measures.

can be interpreted as if we would look at the yield change in percentage points of just one instrument.

The choice of the 10-year maturity in order to capture changes in the long end of the yield curve is standard in the literature.[16] For the German Bund yields the 10-year and 5-year maturities have historically been the most liquid segments.[17] A high level of liquidity ensures a timely response of prices to new market developments.

Figure 2.2 plots our surprises to euro area short-term rates (left panel) and long-term rates (right panel). It is evident that the size and volatility of shocks to short-term rates is much lower than that of long-term rates. Interestingly, even though ECB policy rates approach the lower bound in September 2014, when the main refinancing rate is cut from 0.15% to 0.05%, it is still possible to identify significant shocks to the euro short-term rates after that date. Similarly, the volatility of surprise shocks to average euro area long-term rates does not seem to be affected by announcement of the APP.

Figure 2.2: Surprises over time



(a) EA short-term rates

(b) EA 10-year yields

Table 2.3 reports summary statistics for the largest shocks to euro area short-term rates and long-term rates around ECB announcements. For short-term rates, we find the large surprises concentrated around important rate cuts and announcements of measures targeted towards the euro area banking sector. As regards long-term rates, our surprises capture quite well the effects of the most important unconventional policy measures by the European Central Bank between 2012 and mid-2016. We find large positive surprises around the announcement of the Asset Purchases Program, around the announcement in July 2013 that interest rates would "remain at present or lower levels for an extended period of time" (forward guidance) and around the famous "Whatever it takes"-speech by the President of the ECB, Mario Draghi in July 2012 (cf. Table 2.3).

[16]See for example Rogers et al. (2014), Curcuru et al. (2015) and Fratzscher et al. (2016a).

[17]See Figure 1 of Ejsing and Sihvonen (2009) for a graph of the daily trading volumes (EUR billion) as a function of time-to-maturity (years) We expect the level of the trading to have changed over time but not the overall pattern of liquidity with respect to the term structure.

Table 2.3: Summary table of the largest and smallest monetary policy surprises (inverted sign)

The tables show the largest and smallest monetary policy surprises for short-term rates and 10-year yields respectively. The sign is inverted, such that a decrease intraday rates is measured a positive monetary policy surprise. The tables are sorted according to the largest (smallest) values of the monetary policy surprised.

(a) Large monetary policy surprises to short-term rates

			60 min inverse rate change (%)		Daily Returns (%)		
Date	Event		**EA ST rates**	EA 10-year yields	S&P350	WE Bond	EUR/USD
Positive Surprises to short-term rates ($\cdot > 0.025$)							
05/07/2012	GC meeting, MRO rate decreased to 0.75%, deposit facility rate to 0	Standard MP	**0.09**	-0.01	-0.11	0.05	-1.03
05/06/2014	Targeted Longer-Term Refinancing Operations (TL-TRO) Announcement	Balance Sheet	**0.04**	0.03	0.42	0.20	-0.05
04/09/2014	GC meeting, MRO rate decreased to 0.05%	Standard MP	**0.03**	0.04	1.17	0.08	-1.30
Negative Surprises to short-term rates ($\cdot < -0.025$)							
06/02/2014	GC meeting, rates unchanged	No action	**-0.03**	-0.03	1.45	-0.26	0.50
08/05/2014	GC meeting, rates unchanged	No action	**-0.03**	0.05	1.04	0.23	-0.43
03/12/2015	GC meeting, deposit facility cut by 10 bps to -0.30%	Standard MP	**-0.05**	-0.16	-3.29	-1.07	2.63

(b) Large monetary policy surprises to 10-year yields

			60 min inverse rate change (%)		Daily Returns (%)		
Date	Event		EA ST rates	**EA 10-year yields**	S&P 350	WE Bond	EUR/USD
Positive Surprises to 10-year yields ($\cdot > 0.075$)							
26/07/2012	"Whatever it takes" London speech	Confidence Channel	-0.01	**0.13**	2.46	0.36	1.46
04/07/2013	GC meeting, Open-ended guidance	Forward guidance	0.01	**0.12**	2.47	0.17	-0.45
22/01/2015	GC meeting, APP announced	Balance sheet	0.01	**0.09**	1.60	0.27	-1.47
07/11/2013	GC meeting, MRO rate decreased to 0.25%	Standard MP	0.00	**0.08**	0.03	0.32	-1.07
22/10/2015	GC meeting, willingness to cut rates and expand QE	Balance Sheet/Forward guidance	0.00	**0.08**	2.11	0.37	-1.71
Negative Surprises to 10-year yields ($\cdot < -0.075$)							
06/06/2013	GC meeting, rates unchanged	Downward revision of economic outlook	-0.01	**-0.08**	-1.16	-0.40	0.83
03/12/2015	GC meeting, deposit facility cut by 10 bps to -0.30%	Balance sheet (APP not expanded) and rates not decreased as expected	-0.05	**-0.16**	-3.29	-1.07	2.63
02/08/2012	GC meeting, OMT considerations announced but no details	Balance sheet (disappointment of no immediate action)	-0.02	**-0.20**	-1.26	0.18	-1.12

Interestingly, the "Whatever it takes"-speech by the President of the ECB is associated with the largest positive surprise to average euro area long-term rates, but with a marginal negative surprise (i.e. a rise) in short-term rates. This stresses the importance to keep a distinction between the identification of the impact of ECB announcements through short-term and long-term rates. Indeed, Table B.3 reports the correlation among short-term rates, long-term-rates and our two surprise indicators. In the more recent past (after September 2014) there is a strong correlation between long-term and short-term surprises. Furthermore all single instruments from which we compose our aggregates are strongly correlated. However, in the first part of the sample (from January 2012 to September 2014), the correlation between the Bund and the other sovereign yields is negative and the correlation between the Bund and euro area short-term rates remarkably low. This means there were different channels at work during the early part of our sample and many of the efforts of monetary policy were concentrated on restoring the confidence of Euro area investors.

While a classification of surprises is relatively straightforward for the larger surprises (cf. Table 2.3) it is hard to uniquely assign our whole universe of 63 surprises to a certain set of policies. We do split the sample around the period when markets started to expect a major balance sheet expansion by the ECB through purchases of public sector bonds – September 2014 – in order to distinguish the impact of the ECB APP from the set of conventional and unconventional measures that had been adopted between 2012 and mid-2014.

2.4 Empirical methodology

Our goal is to assess the effect of euro area monetary policy surprises on the reallocation measures defined in section 2.3.3: total reallocation ($\Delta w_{i,t}$) across asset classes (i=1,2, ..., 8), active reallocation, passive reallocation through returns and passive reallocation through FX effects on the fund share level. Moreover, we look also at a simple measure of fund flows in percent of TNA ($100 \cdot f_{i,t}/A_{i,t}$). Our baseline regression approach is captured by the following equation:

$$
\begin{aligned}
(\text{Reallocation\_measure})_{i,t} = \beta_{i0} &+ \sum_{j=0}^{4} \theta_{ij} (\text{MP\_surprise})_{t-j} \\
&+ \sum_{k=1}^{4} \beta_{ik} (\text{Reallocation\_measure})_{i,t-k} \\
&+ \sum_{l=0}^{4} \boldsymbol{\gamma}_{il} (\text{Controls})_{i,t-l} + \varepsilon_{i,t}
\end{aligned}
$$

where the impact of our monetary policy surprises is captured by the vector θ estimated for each combination of: (i) reallocation measure and (ii) asset class. However, by definition, our reallocation measures are constructed in a way that they sum up to 0 across categories. We exploit this feature in our approach by imposing an additional constraint on the fitted values and estimate a joint regression across asset classes for each dependent variable, i.e. the measures of active, passive and total reallocation. The econometric approach of our joint regression specification is outlined in Appendix B.1. Furthermore we discuss stationarity and exogeneity assumptions in in Appendix B.2 which also includes some information regarding model selection.

In our main specification, we look at the effect of monetary policy surprises over a one-week horizon, to allow for a lagged reaction of fund investors to news. For the one-week horizon we report $\sum_{j=0}^{4} \theta_{ij}$ and test whether it significantly differs from 0 using a two sided test (Wald-Test). This would capture the cumulative effect of a monetary policy shock over the course of one week. Flows, active reallocation and total reallocation are ultimately driven by (unsophisticated) investors, which are slower at incorporating new information.

A second specification looks at the contemporaneous effects of monetary policy, testing whether the contemporaneous coefficient θ_{i0} is statistically significant, excluding the lags $1-4$ from our estimation equation. In this case, we are mainly concerned about the passive return and FX effects that are driven by the reaction of asset prices, which are forward-looking and embed immediately the new information. Therefore, the contemporaneous effect of our surprises is the relevant one for these measures.

The main specification includes lagged dependent variables, and a number of control variables, whose impact is captured by the coefficient matrix $\boldsymbol{\gamma}$. In order to control for additional pull and push factors that may influence investors' decisions, we include the change in the CITI Economic surprise index for the euro area (lagged) and the relevant one(s) for the respective geographic focus of the funds (contemporaneous and lagged): G10 economies and emerging markets. This index tracks on a daily basis to what extent actual economic releases[18] have been beating consensus forecasts. Finally, we include a dummy that differs from 0 for days with inconsistent data in the reports from EPFR.

We present our main results in Tables 2.5–2.6. Each line reports the sum of the relevant coefficients associated with the impact of a monetary policy surprise based on a joint regression for each the dependent variable.

2.4.1 Benchmark regressions

We compare our results on passive reallocation measures with the daily change in several benchmark indices and the euro-dollar exchange rate as dependent variables. This ensures that our results for passive rebalancing through returns and exchange rate effects properly

[18]These releases include monetary policy decisions by the respective central banks.

Table 2.4: Summary statistics

Description	Unit	Summary Statistics N	mean	sd	min	max
Surprises (TR Tick History)	*60-min yield change*					
EA_10Y_rates	%-points	63	0.005	0.052	-0.201	0.134
German 10-year yield	%-points	62	0.003	0.035	-0.122	0.103
Spanish 10-year yield	%-points	62	-0.010	0.073	-0.218	0.310
Italian 10-year yield	%-points	63	-0.007	0.077	-0.274	0.340
EA_ST_rates	%-points	63	-0.001	0.017	-0.050	0.093
Weekly EONIA OIS	%-points	63	-0.000	0.017	-0.076	0.037
1-month EONIA OIS	%-points	63	0.002	0.022	-0.106	0.055
3-month EONIA OIS	%-points	63	0.002	0.021	-0.095	0.063
EPFR Raw Measures (All Funds)						
Total Net Assets – $A_{i,t}$	Euro (billion)	9336	69.194	30.081	14.886	145.381
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	9328	0.024	0.554	-5.803	3.364
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	9328	-0.007	0.172	-3.524	2.730
EPFR Portfolio Measures						
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	9328	0.000	0.016	-0.198	0.198
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	9328	-0.000	0.056	-0.618	0.506
Passive reallocation (due to FX changes)	%-points	9328	-0.000	0.043	-1.366	1.277
Total Reallocation –$\Delta w_{i,t}$	%-points	9328	0.000	0.071	-1.359	1.281
Benchmarks	*Daily Returns (euro-based)*					
WE Equity - S&P EUROPE 350	%	1167	0.031	1.054	-6.836	4.188
USAPJ Equity - S&P 500 COMPOSITE	%	1167	0.062	0.973	-6.110	4.156
GLOB Equity - S&P GLOBAL 1200	%	1167	0.045	0.855	-6.005	4.098
EM Equity - MSCI EM USD	%	1167	0.010	0.996	-7.145	5.015
WE Bonds - Barclays Pan-European Aggregate EUR	%	1167	0.011	0.194	-1.143	0.770
USAPJ Bonds - Barclays U.S. Aggregate USD	%	1167	0.014	0.586	-3.287	2.692
GLOB Bonds - Barclays Global Aggregate USD	%	1167	0.019	0.574	-3.192	2.640
EM Bonds - Barclays EM USD Aggregate USD	%	1167	0.013	0.590	-3.047	2.220
EUR/USD – Exchange rate	%	1167	-0.012	0.561	-2.081	2.634

reflect price or exchange rate adjustments (keeping in mind that a simultaneous increase in market values across categories does not necessarily lead to passive reallocation – it is the differential effect across categories that matters). For the benchmark indices we obtain daily returns from Thomson Reuters Datastream.

We use broad stock indices and bond benchmarks that include both government and corporate debt. All indices are computed in USD except the Pan-European Aggregate Bond Index and the S&P 350 Europe Index, which we use as a benchmark for bond funds focused on Western Europe. We convert the returns of the US-dollar based indices to euro. Table 2.4 also shows summary statistics for these variables.

We use the same estimation equation as above, including lagged bechmark returns and the CITI Economic surprise indices as control variables. We estimate each equation separately.

$$
\begin{aligned}
(\text{Benchmark\_return})_{i,t} = \beta_{i0} &+ \sum_{j=0}^{4} \theta_{ij} (\text{MP\_surprise})_{t-j} \\
&+ \sum_{k=1}^{4} \beta_{ik} (\text{Benchmark\_return})_{i,t-k} \\
&+ \sum_{l=0}^{4} \boldsymbol{\gamma}_{il} (\text{Controls})_{i,t-l} + \varepsilon_{i,t}
\end{aligned}
$$

2.5 Main Results

We provide results for two different types of monetary policy shocks, one to euro area short-term rates and one to euro area long-term rates, in two separate tables, Table 2.5 and Table 2.6, respectively. We also split our sample period. In each table, we first report the results for our entire sample period from 2012 to mid-2016 (panel a). Then, we look at the effects during the pre-APP period from January 2012 to August 2014 (panel b). Finally, we look at the period in which the European Central Bank was conducting the Asset Purchase Programme (panel c). Following Altavilla et al. (2015), we split the sample in September 2014, since a series of announcements related to the APP preceded the official launch of this programme in January 2015. The analysis of time variation in parameters provides statistical support for the choice of this particular break point. We sequentially estimate Chow Test-statistics with respect to a break in all regression parameters at time t (Hansen, 2001) and find a sharp increase in the test statistic in mid-2014.[19]

As discussed, we present the results for the main specification with 4 lags of our dependent variable to allow for a delayed response of investors to monetary policy news. However, we check the results also with only the contemporaneous impact of the monetary policy surprise (see Table B.6 and B.7 in the Appendix) and with 2 lags.[20]

The interpretation of the effects of our surprises are straightforward as all variables have the same unit of measurement. For instance, a typical large positive monetary policy surprises, say a two standard deviation shock – is characterised by a decline in euro area short-term rates by 3-4 basis points and in average euro area long-term yields by 10 basis points (see Table 2.3). In turn, the impact of a large shock to average euro area long-term yields – a decline by 10 basis points – would lead to an increase in the portfolio weight of Emerging Market equity by 0.13 percentage points over one week, on the back of an *active* reallocation by 0.01 percentage points and, in particular, a *passive* reallocation due to the

[19]The results of this analysis are not shown for reasons of space and available from the authors upon request.

[20]The latter set of results is available from the authors upon request.

FX effect, almost 0.11 percentage points, as the euro depreciates by around 1.2%, boosting the weight of funds that are not denominated in euro (see fifth column of Table 2.6a).

2.5.1 Results with surprises to euro area short-term rates

We start by analysing the impact of shocks to the euro area short-term rates following important ECB monetary policy announcements. As shown in Section 3, our sample period is characterised by relatively stable policy rates – the main refinancing rate of the ECB gradually declined from 1% to 0% – and relatively subdued policy surprises identified through changes in euro area short-term rates. Tables 2.5 shows the results of the impact of these monetary policy surprises on our portfolio of euro area investors. Generally, it is difficult to identify a statistically significant effect of these surprises on flows and the active reallocation to specific asset classes. Investors seem to reduce the weight of equity funds dedicated to non-euro area developed economies following positive surprises identified through short-term rates, as the active reallocation coefficient is negative and statistically significant (see first row of Table 2.5a). However, the result does not appear to be particularly robust across different time periods (see Table 2.5b and 2.5c), using a different lag structure of the main specification (see appendix) and is not mirrored by the reaction of flows (as % of TNA, i.e. not aggregated in a single portfolio) to ECB announcements. If any, splitting the sample between the pre-APP period (panel b) and the APP-related period (panel c), we may note that easing surprises lead to purchases of bonds of non-euro area developed economies – see statistically positive coefficient for flows into USAPJ and Global bond funds and the active reallocation into Global bond funds – possibly reflecting a search for yield.

However, Tables 2.5a-2.5c show that ECB monetary policy announcement surprises lead to sharp exchange rate and price fluctuations that in turn generate significant passive shifts in the portfolio of euro area investors. The impact on exchange rates is significant. An unexpected large easing – say a decline in euro area short-term rates by 3 to 4 basis points – leads to a depreciation of the euro against the US dollar by around 1% in one week (by 0.6% on the day of the announcement, as shown in Table B.6 in the appendix).[21] Interestingly, the impact is much larger in the second phase of ECB unconventional monetary policies, those that were associated with the announcement of purchases of euro area government securities. The absolute value of the impact of a large positive surprise on the exchange rate over one week (on the same day) increases from 0.6% (0.3%) in the sample until mid-2014 to 2.3% (1.4%) in the period starting from September 2014.[22] As a result, a positive monetary policy surprise triggers on average a passive reallocation out of European equity

[21]Precisely, a two-standard deviation shock to euro area short-term rates around ECB announcements corresponds to 0.034 percentage points, therefore to quantify the impact is sufficient to divide the coefficients by around 3 and then by 10.

[22]Ferrari et al. (2017) show that the FX impact of monetary policy of major central banks, not only of the ECB, has been growing significantly and is stronger the lower the level of interest rates.

Table 2.5: Main results Euro area short-term rates (impact over 4 lags)

The table shows the (cumulative) effect associated with the surprise change in Euro area short-term rates. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 3.2 in the main text for the definition of dependent variables). For instance, the first coefficient on the top-left corner of the table indicates the one-week impact of the surprise change in Euro area short-term rates on the active reallocation to Western European equity funds.

(a) Impact of a surprise change in EA ST rates – full sample

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	0.036	−0.321*	−0.188**	0.113	−0.040	0.114	0.167	0.065
Passive reallocation *return*	1.682	−0.886*	−0.480	−1.691*	0.307	0.174	0.593	0.280
Passive reallocation *FX*	−2.308**	1.221**	0.083	2.126***	−1.290*	−0.283	0.436	0.805***
Total reallocation	−0.464	−0.331	−0.592	−0.085	−0.950	0.169	1.354	1.251*
Separate estimation (equation by equation)								
Flows (% of TNA)	0.746	−1.643	−0.382	1.260	1.223	4.046	1.264	1.135
Surprises	60	60	60	60	60	60	60	60
Observations	1162	1162	1162	1162	1162	1162	1162	1162
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−31.0***	15.0	14.9	13.6	12.5	9.6***	33.3***	34.6***	33.0***

(b) Impact of a surprise change in EA ST rates – before September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.210	−0.294	−0.166	−0.018	0.049	0.180	0.324*	0.065
Passive reallocation *return*	−0.717	−1.230***	−1.042***	−1.856*	1.313***	0.497***	1.932**	0.862**
Passive reallocation *FX*	−1.820**	1.070**	0.174	2.147***	−1.140*	−0.268	−0.113	0.831***
Total reallocation	−2.512**	−1.147*	−0.968**	−0.936	0.359	0.623	2.636***	2.051***
Separate estimation (equation by equation)								
Flows (% of TNA)	−1.346	−1.750	−0.200	0.531	1.378	5.554*	1.801*	0.430
Surprises	36	36	36	36	36	36	36	36
Observations	686	686	686	686	686	686	686	686
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−19.1**	−13.7	−4.9	−6.8	−6.5	8.8***	24.8**	24.4**	22.1**

(c) Impact of a surprise change in EA ST rates – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	0.371	−0.302	−0.255	0.088	−0.080	−0.103	−0.212	0.127
Passive reallocation *return*	8.729***	−0.151	1.342	−1.181	−2.430	−0.938**	−3.913**	−1.793**
Passive reallocation *FX*	−4.123**	2.598**	−1.598	3.044**	−2.913	0.393**	2.054	0.646
Total reallocation	5.795**	2.095	−0.751	1.844	−4.968**	−0.442	−2.841	−1.304
Separate estimation (equation by equation)								
Flows (% of TNA)	3.865	−0.915	−0.807	1.470	1.375	−2.975	0.212	3.691
Surprises	24	24	24	24	24	24	24	24
Observations	471	471	471	471	471	471	471	471
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−67.3***	100.8***	65.6**	74.1***	73.6*	15.2**	62.2**	68.2***	68.0***

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

funds (−0.08 percentage points) and bond funds (−0.04 percentage points), which are largely denominated in euro, and a positive shift in the weight of USAPJ and EM asset classes that include a relatively small share of euro-denominated funds (see Table 2.2). During the APP-period, the passive FX reallocation out of European equity funds peaks at 0.16 percentage points, a significant shift corresponding to 3 standard deviations of the daily distribution of this series.

Asset prices also react dramatically to ECB monetary policy surprises. In particular, bond prices of extra-European bonds rise by around 1.1% (0.7%) over one week (day) following a positive surprise. Even though not statistically significant, the impact on other asset prices is also positive and, as a result, there is no clear trend in the passive reallocation driven by returns. Moreover, splitting the sample, it is evident that, again, the announcement of the launch of the APP-programme was associated with much sharper asset price fluctuations compared to the previous period. Notably, European equity markets rise by 3.4% (1.9%) over one week (day) and extra-European equity markets by around 2.2-2.5% following positive surprises since the autumn of 2014 (last row of Table 2.5c). Bond prices also rise by around 2% outside Europe and by 0.5% in Europe. Eventually, in this second phase of ECB unconventional policies, these relative changes in asset prices lead to a passive shift in the portfolio allocation towards European equity funds, increasing their weight by 0.30 (0.14) percentage points over one week (day). This shift is large and offsets the negative passive FX effect driven by the euro depreciation and, all together, results in a total reallocation of the portfolio of euro area investors into European equity funds at the expenses of European bond funds, whose weight is affected by the combination of a negative FX effect and a negative return effect (relative to other asset classes) since the autumn of 2014.

2.5.2 Results with surprises to euro area 10-year yields

Tables 2.6a-2.6c show the results for the monetary policy surprise identified through the change in average euro area long-term interest rates.[23] As in the previous identification, we find only scant evidence of active reallocation towards specific asset categories. A surprise loosening of monetary policy leads to an *active* reallocation to Emerging Market equity funds across the whole sample (Table 2.6a, first row), in turn driven by a positive impact in the first part of our sample until mid-2014. In particular, in this first period, the active reallocation towards Emerging Market equity funds comes at the expenses of a rebalancing out of European bond funds. The last row of panel (b) shows that emerging stock markets had the strongest positive price reaction to a monetary policy surprise, even though not

[23] We use an unweighted average in the baseline specification. Results with monetary policy surprises that are weighted by outstanding volume of debt securities issued by the general government or the GDP of each of the three countries do not differ markedly from the unweighted measures.

statistically significant, whereas European bonds display the weakest performance. This provides some support to the body of evidence suggesting that inflows into investment funds are positively correlated with their return performance (see Levy and Lieberman (2015)). However, even for statistically significant coefficients, the size of impact on the active reallocation measure of a large shock – say, by 10 basis points – to average euro area long-term rates is relatively small (generally, close to one standard deviation of the distribution). Additionally, these results are not robust to the use of a different lag structure. Flows into EM equity funds are also statistically significant following an unexpected ECB monetary easing, amounting to 0.08% of their TNA, which corresponds to around EUR 90 million over one week. However, these numbers are not particularly large when compared to the historical volatility of the series (see Tables B.4 and B.5 in the Appendix), confirming one of the main findings of Fratzscher et al. (2016a) regarding the impact of ECB policies between 2007 and 2012. Finally, we may note that the negative flows out of European bond funds in the first phase of ECB policies until mid-2104 turn positive after September 2014. In this latter period, the impact of a large positive surprise to long-term yields is associated with an inflow into European bond funds corresponding to 0.2% of TNA, which however does not translate into a significant *active* shift in the portfolio. Overall, matching these results with the impact of shocks identified through short-term rates, we may conclude that the portfolio balance channel of ECB unconventional policies is substantially muted according to our evidence.

Again, ECB monetary policy surprises identified through changes in long-term yields are associated with fluctuations in asset prices and exchange rates, which trigger a passive reallocation of the portfolio of euro area investors (Table 2.6a). Differently from the previous identification through short-term rates, though, the reaction in asset prices is mainly visible in the second part of our sample (Table 2.6c), not in the period up to August 2014 (Table 2.6b). This suggests that long-term yields may be a good proxy of the impact of balance sheet unconventional monetary policies targeting public debt, but not necessarily of those polices working through forward guidance on short-term rates through the expectations hypothesis. Focusing on the impact of a large positive surprise – say a decline in long-term yields by 10 basis points – in the APP-period, we find that the response of exchange rates and asset markets in Table 2.6c are of a similar magnitude compared to the previous identification (Table 2.5c). In particular, the euro depreciates by 2.6% (1.6%) against the US dollar in one week (day). European equity markets display the strongest performance +4.1% (1.9%) over one week (day), followed by extra-European equity markets, in particular Emerging Markets (+3.8% in one week). Bond markets outside Europe also react positively to ECB announcement surprises, rising by almost 3% (1.8%) over one week (day). European bond markets, again, are those showing the weakest positive performance (+0.6% in one week). As a result the passive reallocation effects are largely similar to the previous

Table 2.6: Main results Euro area 10-year yields (impact over 4 lags)

The table shows the (cumulative) effect associated with the surprise change in Euro area 10-year yields. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 4.2 in the main text for the definition of dependent variables). For instance, the first coefficient on the top-left corner of the table indicates the one-week impact of the surprise change in Euro area 10-year yields on the active reallocation to Western European equity funds.

(a) Impact of a surprise change in EA 10Y yields – full sample

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.099	−0.061	0.004	0.124*	−0.019	0.010	0.043	0.015
Passive reallocation *return*	1.390**	−0.082	0.299	0.319	−0.447*	−0.189*	−0.806*	−0.420**
Passive reallocation *FX*	−1.068***	0.598**	0.163*	1.051***	−0.464	−0.365	0.018	0.359***
Total reallocation	0.364	0.336	0.445**	1.278**	−0.905**	−0.512	−0.774*	−0.140
Separate estimation (equation by equation)								
Flows (% of TNA)	−0.207	−0.040	0.533	0.769**	−0.052	0.736	0.533	0.440
Surprises	63	63	63	63	63	63	63	63
Observations	1162	1162	1162	1162	1162	1162	1162	1162
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−12.0**	17.7**	15.7**	15.2**	18.4***	3.9***	13.5**	13.9**	13.4**

(b) Impact of a surprise change in EA 10Y yields – before September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.178	−0.003	0.049	0.194**	−0.149**	0.025	0.034	0.058
Passive reallocation *return*	0.267	−0.018	0.129	0.391	−0.063	−0.091	−0.288	−0.275
Passive reallocation *FX*	−0.504*	0.296	0.107	0.842**	−0.218	−0.389	0.068	0.298*
Total reallocation	−0.315	0.206	0.268	1.153	−0.394	−0.371	−0.182	−0.000
Separate estimation (equation by equation)								
Flows (% of TNA)	−1.083	0.191	0.757	0.798	−1.698***	1.146	0.259	0.638
Surprises	36	36	36	36	36	36	36	36
Observations	686	686	686	686	686	686	686	686
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−3.8	4.5	5.4	4.1	6.6	1.4	4.2	4.8	3.6

(c) Impact of a surprise change in EA 10Y yields – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.002	−0.120	−0.040	0.003	0.178	−0.037	0.054	−0.047
Passive reallocation *return*	3.377***	−0.265	0.512**	0.156	−1.132***	−0.413***	−1.679***	−0.687***
Passive reallocation *FX*	−1.798***	1.006***	0.051	1.270***	−0.987*	0.170***	−0.007	0.355***
Total reallocation	1.500**	0.604	0.520	1.294**	−1.883***	−0.174*	−1.771***	−0.472**
Separate estimation (equation by equation)								
Flows (% of TNA)	0.895	−0.125	0.304	0.764*	2.238**	−0.248	1.082	0.252
Surprises	27	27	27	27	27	27	27	27
Observations	471	471	471	471	471	471	471	471
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−25.9***	40.6***	29.5***	33.6***	38.4***	7.8***	28.3***	29.8***	28.9***

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

results. The FX effect leads to a reduction in the weight of European equity and bond funds as the euro depreciates. Nevertheless, the weight of European equity funds benefit from a strong offsetting *passive* return effect (+0.34 percentage points in one week), which is instead negative for European bond funds, as well as other bond categories. Eventually, summing up all components, ECB announcement surprises lead to a passive reallocation into European and Emerging Market equity and out of bond funds, in particular European bonds.

2.6 Robustness

We provide a series of robustness checks to our results, distinguishing between the effects of large and small surprises, positive versus negative shocks and controlling that our results are not driven by the particular choice of the universe of funds, drawing a new (and more comprehensive) sample of funds starting from the beginning of 2014. Finally, we study the long-term impact on portfolio weights. In our robustness checks, we focus on the second phase of ECB policies since the autumn of 2014, where our study finds evidence of significant shifts in asset allocation due to price and exchange rate effects.

2.6.1 Categorizing monetary policy surprises

To assess whether our results are mostly driven by large shocks to prices and yields, we classify the monetary surprises using an exponentially weighted moving average (EWMA) volatility model based on daily trading between 13:30 and 14:30 Frankfurt time.[24] Surprises that exceed $4.5|\sigma_{H,t}|$ are classified as tail events. In our empirical specification we distinguish between two types of shocks: tail events and small surprises. We estimate two separate vectors, θ^{normal} and θ^{tail}, for each type of shock by multiplying our monetary policy surprises with a dummy that equals one for tail surprises. We use the regression specification outlined in section 2.4.

Table 2.7 reports the results of this robustness check. In general, the direction of the impact of normal shocks is usually similar to that of tail shocks. However, the main quali-

[24]For the EWMA model we use weights that are corrected for a finite observation window (Pesaran, 2015), and initialize our model with data from 2011. Denoting by H the length of the backward-looking observation window, we can compute the volatility at time t as:

$$\sigma_{H,t} = \sqrt{\sum_{\tau=0}^{H} \frac{(1-\lambda)\lambda^{\tau}}{1-\lambda^{H+1}} \cdot r_{t-1-\tau}^{2}}.$$

The return r_t is a daily time series of one-hour changes in (median) bid yields and (median) bid prices between 13:30 and 14:30 Frankfurt time, which we assume to be centered around 0. We use a decay factor of $\lambda = 0.97$ (slow decay, more weight on past observations) and select subsets of our data such that $H = 200$ in terms of trading days.

tative and quantitative results of the previous section are clearly driven by tail shocks. In particular, the passive FX effect out of European equity and bond funds and the positive return effect into European equity funds and out of bond funds are statistically significant when isolating tail shocks. The size of the impact of tail shocks, moreover, is very similar to those estimated across the whole sample of shocks. Therefore, unsurprisingly, we may conclude that only major ECB announcements lead to significant shifts in the portfolio of euro area investors.

Moreover, we split our announcements into positive and negative monetary policy surprises. Overall, we find that the effects of positive and negative surprises do not seem to differ (see Table B.8 in the Appendix).

2.6.2 Alternative fund universe

Our sample starts in 2012 and covers almost 30% of the universe of Luxembourg-based funds. The coverage of funds by EPFR increases through time and we wonder whether our results are affected by the particular universe of funds. For this reason, we drew a new sample of Luxembourg-based funds starting from 2014 and checked whether the main results for the APP-period continue to hold. Table B.9 shows the robustness of our results across different fund universes. We formally test for the equality of the coefficients of interest, by jointly estimating the same regression from two samples in a SUR setup. The subsequent test for the equality of the coefficients takes into account the covariances across the coefficients from different samples. Indeed, we never reject the null hypothesis that each coefficient of interest is equal across the two samples.

2.6.3 Retail vs. institutional investors

In Tables B.10 and B.11 we look a flows and active reallocation by investor type, distinguishing between fund shares marketed to retail investors and those targeting institutional investors or that have a minimum investment of USD 100,000. Generally, it appears that flows in and out of fund shares targeting institutional investors react more strongly to our monetary policy surprises compared to fund shares targeting retail investors. Interestingly, the active reallocation into emerging market equity funds – in the sample before September 2014 – in response to a change in 10-year yields that we have underlined in Section 5.2 is clearly driven by institutional investors, not by retail investors (see panel (b) of Table B.11). This suggests that institutional investors follow active portfolio strategies more often than unsophisticated retail investors, who instead prefer a buy-and-hold strategy.

Table 2.7: Main results Euro area rates (outliers)

The table shows the (cumulative) effect associated with the surprise change in Euro area rates. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 3.2 in the main text for the definition of dependent variables). For instance, the first coefficient on the top-left corner of the table indicates the one-week impact of the surprise change in Euro area 10-year yields on the active reallocation to Western European equity funds.

(a) Impact of a surprise change in EA 10Y yields – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation (normal)	0.060	−0.152	0.065	0.157	0.328	−0.073	−0.303	−0.086
Active reallocation (tails)	−0.009	−0.118	−0.065	−0.023	0.157	−0.035	0.111	−0.032
Passive reallocation *return* (normal)	8.590***	−0.728	0.846	−0.448	−2.038	−0.775*	−3.058*	−1.905***
Passive reallocation *return* (tails)	2.384***	−0.212	0.430	0.235	−0.924**	−0.335***	−1.362***	−0.461**
Passive reallocation *FX* (normal)	−1.789	0.737	0.438	1.405	0.007	0.138	−0.995	0.324
Passive reallocation *FX* (tails)	−1.727***	1.006***	−0.015	1.192***	−1.138***	0.166***	0.179	0.353***
Total reallocation (normal)	6.761***	0.004	1.258	0.924	−1.781	−0.429	−4.600*	−1.889***
Total reallocation (tails)	0.544	0.677	0.373	1.289**	−1.827***	−0.129	−1.190*	−0.214
Separate estimation (equation by equation)								
Flows (% of TNA) (normal)	2.117	0.279	1.780	1.788	3.912	2.136	−0.579	−0.051
Flows (% of TNA) (tails)	0.687	−0.238	−0.016	0.577	1.951**	−0.792	1.319	0.370
Normal Surprises	20	20	20	20	20	20	20	20
Tail Surprises	7	7	7	7	7	7	7	7
Observations	471	471	471	471	471	471	471	471
Benchmarks (normal/tails):	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−31.303*	75.884***	21.051	47.856***	45.626**	11.414***	26.959*	33.871*	30.818**
−24.906***	31.170***	27.767***	31.314***	36.574***	7.082***	24.239***	25.588***	26.563***

(b) Impact of a surprise change in EA ST yields – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation (normal)	1.531**	−0.407	−0.256	0.162	−0.613	−0.104	−0.778	−0.285
Active reallocation (tails)	−0.646***	−0.247*	−0.239***	−0.114	0.623***	−0.092*	0.224	0.497***
Passive reallocation *return* (normal)	8.610*	−0.068	0.412	−3.582	−0.570	−0.613	−3.159	−1.893
Passive reallocation *return* (tails)	9.228***	−0.165	2.292***	1.567**	−4.694***	−1.279***	−5.098***	−1.929***
Passive reallocation *FX* (normal)	−2.378	2.150	−4.520	2.196	−2.538	0.147	4.969	0.090
Passive reallocation *FX* (tails)	−5.871***	3.084***	1.012***	3.906***	−3.069***	0.622***	−0.858*	1.173***
Total reallocation (normal)	10.131**	1.470	−4.602	−1.458	−2.731	−0.504	0.003	−2.669*
Total reallocation (tails)	2.135*	2.752***	2.837***	5.357***	−7.049***	−0.447***	−6.220***	−0.358
Separate estimation (equation by equation)								
Flows (% of TNA) (normal)	10.182**	−1.782	−0.346	1.393	−2.275	−4.039	−2.940	−0.930
Flows (% of TNA) (tails)	−1.784*	−0.328	−0.958	0.550	6.311***	−1.932	2.479**	8.192***
Normal Surprises	23	23	23	23	23	23	23	23
Tail Surprises	1	1	1	1	1	1	1	1
Observations	471	471	471	471	471	471	471	471
Benchmarks (normal/tails):	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−60.775	74.734	24.670	48.989	12.173	11.462	39.751	53.916	51.935
−75.648***	113.066***	98.123***	108.591***	140.631***	18.912***	75.779***	77.444***	84.087***

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

2.6.4 Benchmarking to Fratzscher et al. (2016a)

We have extended our results covering the period between January 2010 – the first sample we had extracted from EPFR with a satisfactory coverage of bond funds – and September 2012 in order to estimate the effects of monetary policy surprises for a period that partially overlaps with the sample of Fratzscher et al. (2016a).[25] We find a statistically significant reallocation into funds investing in Western European bonds following a positive surprise change (a decline) in EA short-term interest rates and a reallocation out of equity in advanced economies and into emerging market equity funds following a positive surprise change (a decline) in EA long-term interest rates (cf. Table B.12. These results largely confirm that ECB monetary policy measures – in particular the Outright Monetary Transactions announcements in the summer of 2012 – boosted global confidence, somewhat reviving the appetite for euro area debt and emerging market securities, as shown by Fratzscher et al. (2016a).

2.7 Conclusion

We study the impact of major ECB monetary policy announcements on a portfolio of Luxembourg-based investment funds, broadly representative of euro-area investors, daily, between 2012 and mid-2016. This period includes a variety of different unconventional measures. In order to provide evidence on the different channels of these unconventional policies, we distinguish between *active* portfolio reallocation, driven by the redemptions or injections by investors, and *passive* portfolio rebalancing, triggered by valuation effects related to changes in asset prices and exchange rates. We find that the portfolio balance channel of ECB policies is generally muted. There is only scant evidence of active reallocation by investors into specific asset classes, which is not robust to different specifications of the model, different sample periods or the identification of the monetary policy shock. However, the asset price impact and exchange rate impact of ECB announcements are large, in particular in the APP-period starting from September 2014, leading to significant shifts in the total portfolio of euro area investors. As the exchange rate of the euro significantly depreciates following positive ECB monetary policy surprises, the portfolio of euro area investors passively shifts towards extra-European funds. This result is robust to different sample periods and identifications of shocks. The asset price impact may change over time, but it is very large following the announcement of the APP by the ECB, benefiting in particular European equity markets, but with important positive spillovers to other – extra-European – equity and bond markets. As a results of these asset price changes, the portfolio of euro

[25] Fratzscher et al. (2016a) identify the effects of ECB policies via dummy variables on days of important ECB announcements as well as explanatory variables capturing V/SLTRO liquidity injections and SMP purchases.

area investors passively shifts towards riskier assets, in particular European and Emerging Markets equity funds, and out of bond funds.

Overall our empirical findings provide robust evidence that fund investors are affected by monetary policy mainly through the impact it has on asset prices by changing expectations of future interest rates (the signalling channel). We find little evidence of retail and institutional fund investors being exposed to the portfolio balance channel, whereby monetary policy operates by changing risk premia and inducing active portfolio reallocation. Since our main element of analysis is fund investor behaviour, including unsophisticated retail investors, our findings are not necessarily in contradiction with the theories behind the portfolio balance channel, since these theories operate through arbitrageurs who can be thought of as relatively sophisticated investors. Our empirical evidence is also consistent with the empirical evidence on the behaviour of investors in mutual funds, who are generally reluctant to sell past winners, and the growing literature on rational inattention, predicting that unsophisticated investors adjust their portfolios only rarely.

Chapter 3

Process or Candidate: The International Community and the Demand for Electoral Integrity[1+2]

3.1 Introduction

"America adopted a somewhat different approach. Where Russia used force and fear to enhance the results of a democratic election, the U.S. used money."[3]

Despite much weakening of the sovereignty norm over the last decades, there is one area where this norm remains very powerful: there is widespread consensus that foreigners should not interfere or intervene in the democratic elections of another country, unless possibly to support the democratic process. However, this norm is observed mainly in the breach. According to a new dataset, actions by outsiders to support a candidate running for elections are observed in one-third of all elections in the world.[4]

In this paper, we outline the conceptual distinction between processes, the "how" of elections, and parties competing in them, the "who" of elections. We then use this distinction to develop a theory of electoral intervention. The theory is built on a formal model of elections with bias. Domestic parties compete for office using their resources and popularity, whether they win or not is a function of the institutional rules of the game. Outsiders have a choice of investing in the how, the who, or both. Outside actors care, to a degree that varies, about cleaner (more legitimate) contests and about the policy platform of the prospective leaders.

[1]This chapter is joint work with Nikolay Marinov.

[2]This chapter has previously been published in the "American Political Science Review" as Bubeck and Marinov (2017). Permission for reproduction has been granted by Cambridge University Press via License Number 4354661022051 on May 23, 2018.

[3]Brian Landers. *Empires Apart: A History of American and Russian Imperialism.* Pegasus, New York, 2009.

[4]See Bubeck and Marinov (2018) for a more extensive data collection. This is likely an underestimate as many interventions may be clandestine.

The primary contribution we make is theory-building. Neither the possibility of links between processes and candidates nor the existence of such a distinction have been studied. The model produces predictions on three quantities of interest: the amount and mix of resources invested by the outsider in the election, incumbent win or loss, and the degree of fraud (or compliance with democratic rules). Some of the comparative statics can better illuminate cases that so far have been puzzling. Others represent novel testable implications. We present some preliminary evidence, illustrating the patterns predicted by the theory.

A key insight we seek to convey is that outsiders' interest in elections of other countries can be conceived of as a mixture of two types of concerns: geo-politics and democratic liberalism. Concern with geo-politics motivates investment in candidates: this investment grows as the country's viable candidates grow further apart. Concern with liberalism motivates investment in fair contests.

Notably, a "cleaner" contest changes the probability of specific candidates to win, feeding into the geo-political calculations of the intervener. This makes investments in candidates and processes mutually dependent. The observation that clean contests imply a different probability of winning – for incumbent and opposition – is not new by itself.[5] We formalize it, alongside partisan concerns by the outsiders for government or opposition to win, and demonstrate a number of non-trivial implications.

For example, we can explain why non-democratic states, such as Qatar, would invest in democracy-promotion during the Arab Spring.[6] Instead of viewing such behavior as an insincere aberration, we show that it may be a sensible strategy. Because investing in fair elections helps support for the friendly opposition parties to go farther, democracy-promotion is an optimal strategy even for a state that attaches no intrinsic value to fair elections.

Our argument can readily explain a neglected, yet prominent aspect of foreign interventions in elections: namely that, historically, outside powers have often relied on a mix of interventions. We show why outside powers would not invest exclusively in one strategy, i.e., the "how", or the "who" in elections. If the friendly party is in opposition, investing both in a fair election and in more domestic appeal for the opposition is optimal for the foreigners. An outsider that prizes clean elections, would invest in fairer rules of the game in a country governed by a friendly incumbent, while using candidate interventions to offset possible electoral losses of the incumbent.

Election interventions often entail cases where different powers are intervening on different sides: for the government or the opposition.[7] We call these situations "election wars". Existing studies do not distinguish between process-based and candidate-based intervention strategies. Nor do they allow for the strategic adjustment of the behavior of one power in anticipation of the response of another power. Among other things, it is not readily obvious in such cases whether a liberally-

[5] We see it already in Sartori (1976)'s work on competition and competitiveness of democratic party systems.

[6] Sebastian Sons and Inken Wiese, "The Engagement of Arab Gulf States in Egypt and Tunisia since 2011", DGAPanalyse, Nr. 9 October 2015 [LINK] and Kristian Ulrichsen, "Qatar and the Arab Spring: Policy Drivers and Regional Implications", Carnegie Endowment Paper, Sep 24, 2014 [LINK].

[7] See Tolstrup (2009); Risse and Babayan (2015).

inclined foreign power would respond to the entry of an illiberally-minded foreign competitor ("black knight") by increasing or by decreasing investment in democratic process.

Our model allows the possibility to study these puzzles. Take as a starting point the case of a liberal hegemon, e.g., the U.S., intervening, but consider adding a second – illiberal – intervener to the contest. As the stakes for one power increase (meaning, the importance of the election), its candidate does better. When it comes to election quality, there is a twist. If the liberal power likes the opposition, increasing stakes lead to higher investment in candidates and processes, and we have cleaner elections. If the liberal power likes the incumbent, higher stakes increase candidate support, but, at first, lead to less investment in a fair contest. The same holds true for the illiberal power. In this case we might even see a deterioration of democratic standards compared to their level before the intervention.[8]

Thus, contrary to what the literature suggests,[9] rising geo-political importance of a target state is not always bad for democracy. Whether it is or is not, depends on whether the intervener is liberal, on whether it faces a challenger, and whether there is polarization in the policy positions of the government and opposition.

We extend our model in two directions of interest. In one extension, we allow outside powers the option of dispensing with democracy altogether via a coup. We show that increased domestic polarization leads outsiders to abandon election interventions in favor of coups. In another extension, we allow for parties to change their positions in order to attract support from outside patrons. We also demonstrate the conditions under which the latter occurs and the implications for policy polarization.

We contribute to work on elections and democracy. Formal models of elections have been used to try to understand the timing and role of elections as tools of accountability (Fearon, 2011). Lately, scholars have applied them to the study of illiberal contests (Little, 2012; Gehlbach and Simpser, 2015; Rundlett and Svolik, 2016), including those in autocracies (Shih, 2013; Lorentzen, 2013). We introduce the role of outside actors. While we model the effects of intervention on electoral integrity, our work has implications for scholarship on the diffusion of democracy (Gleditsch and Ward, 2006). We help identify the power distributions in world affairs most likely to further democratization.

Our model also allows to study issues such as how the wealthy influence elections, the role of donors for promoting policy agendas in American states, and how foundations fuel change and backlash.[10] The approach is adaptable to the study of interventions in democracy by different actors, subnationally as well as cross-nationally.

[8]The interaction of c and p effectively puts an upper limit on the bias (cf. Section Predictions)

[9]Donno (2013); Kavakli and Kuhn (2016).

[10]See dedicated issue in *PS: Political Science and Politics* (vol. 49, issue 3) for a good overview of these types of problems.

3.2 The Who and the How of Elections: A Theory with Interested Outsiders

Outsiders have a long and illustrious history of casting a "silent ballot" in other countries' elections (Forster, 1963). This attitude was summarized in an infamous *Pravda* editorial. On the eve of the 1945 Finnish elections, the Soviet daily upended the conventional view of the matter when it wrote that "elections are not to be considered internal affairs" for the countries holding them. Soviet Russia, which controlled some Finnish territory, exerted considerable influence in the election. Its main objective was to remove anti-Soviet ministers – elected in 1939 – who led Finland into war with Soviet Russia. The USSR accused some of the ministers of supporting fascism. It also demanded the dissolution of the Finnish veterans' association, "Comrades in Arms", because it believed that the 400,000-plus members would sway the outcome in favor of anti-Soviet parties. Moscow sought to bolster support for the Democratic People's Union (SKDL), which included the Communist Party, and it publicly worried that the elections may be biased against leftist parties. Friendly relations with the Soviet Union, however, were critical at the time because Finland owed the USSR $300 million dollars in war reparations. In statements issued before the election, the Soviets made it clear that financial support for Finland, and even its territorial integrity, depended on the electoral outcome. The elections were free of fraud, and Soviet Russia's party allies performed well.

Elsewhere in Europe, Soviet behavior showed variation. In the Polish elections of 1947, the Soviets helped the government bludgeon its way to victory. The political police recruited, for example, almost half of the electoral commission's members. About eighty thousand people – members and suspected supporters of the non-communist People's party (PSL) – were arrested during the election period. Polling stations were also controlled by the militia and the army. Pro-opposition activists were intimidated and sometimes murdered, many other voters were forced to vote in public.[11]

This type of election-related activism is hardly reserved to the Soviet Union, or the early Cold War. To take a more recent example, European leaders publicly urged the Bosnian electorate to vote for pro-EU candidates in the Presidential and general elections in Bosnia-Herzegovina on the 3rd of October, 2010. British and German foreign ministers William Hague and Guido Westerwelle said in an open letter: "Our message to the Bosnian people is that our countries are sincere in wanting to help and support you, but for that to be successful we need leaders who choose to work with us towards the goal of EU integration."[12]

These cases show outside powers spending resources to either impede or improve the process of voting. They also show outsiders aiming to help a partisan ticket by extending resources to help the party appeal to voters. Understanding these phenomena, and what they imply for electoral

[11] Soon after that Stanislaus Mikołajczyk left Poland in secret, fearing of his own life. LINK.

[12] The letter continued: "...we shall support the Bosnian people and work with leaders who look to the future not the past." See LINK and LINK.

integrity, is important. We proceed to outline a theory that clearly lays out the stakes, actors and set of available choices.

3.2.1 A Model of Outside Interventions in Biased Elections

We start with a simple model. We conceive of elections as manipulated contests (Gandhi and Przeworski, 2009), where manipulation varies along a continuum from low to high (Hyde and Marinov, 2012). For simplicity, we focus on elections in which the incumbent leader (or incumbent political party) is running, the opposition is challenging the incumbent, and if the incumbent loses, the opposition assumes power.

Elections

The outcome of an election is determined by the support among the voters for a certain candidate. There is some vote share χ that the incumbent party would receive if elections were entirely free and fair. Let χ be the support of a candidate, where $0 \leq \chi \leq 1$. Absent any distortion such as an unfair advantage to one of the parties the outcome of the election is determined by the mapping $f(\chi) = \chi$.

Bias

In recent years, there has been an explosion of work on the various ways in which democratic elections can become less democratic (Schedler, 2002; Alvarez et al., 2008). Scholars and practitioners have introduced the concept of electoral integrity: a series of (universal) benchmarks that democratic elections must meet (Norris, 2015). These include voter registration laws, election procedures, district boundaries, how the vote count is conducted, and many others. While the collection and weighting of indicators remains a matter of debate, we borrow a simple insight from existing work. The democratic ideal is obtained when a contest is held under rules that bestow no special advantage to any candidate running in the election. Where electoral rules are without flaws, observed vote share is most likely to reflect the true support of candidates. As rules become less perfect, elections deviate more and more from the democratic paradigm. Usually this deviation has a particular beneficiary and can be represented as bias, or asymmetric advantages. These usually favor the incumbent (office-holding) candidate or party in the contest. We assume that the bias always favors incumbents. Our model, however, can be adapted to study alternative cases where the bias favors the opposition in some elections or does not benefit a particular party.

We formalize bias by uncoupling the final vote share in an election from the true support for a candidate. Let β measure the election's bias in favor of the incumbent. We observe vote share; true incumbent support χ is unobserved. So far, outside intervention of any kind is absent.

Interventions

We define an electoral intervention as a deliberate attempt by a foreign government to change the electoral rules or the appeal of the candidates. We distinguish between pre-election interventions (e.g., which include helping with election campaigns, threatening voters with consequences, insisting on a fair vote) and post-election interventions (e.g., seeking to overturn the results of the elections, making the results stick, or altering the composition of the elected government). In this project, we focus on pre-election interventions. By pre-election, we mean everything before the aftermath of voting. We include the counting of ballots, aggregation and announcement of results. Empirically, many interventions occur pre-election. This distinction would allow future work to study the logic of post-election decisions separately.[13]

We next distinguish between two different types of interventions – *candidate*-interventions and *process*-interventions. We assume that incumbent vote support can be moved away from χ by offering support c for that candidate . We choose the bias β to be a function of some choice argument p, the *process*-intervention a foreign power can undertake. We will also assume that the incumbent benefits when $c > 0$ (the opposition benefits when $c < 0$), and a fairer process results if $p > 0$ (bias grows if $p < 0$).

Examples of *candidate*-interventions would be outsiders conditioning financial transfers to a country on who wins, or threatening to invade if the "wrong" ticket won, or threatening to expel guest workers that are citizens of the target country. Sometimes, economic sanctions amount to pro-candidate interventions (Marinov, 2005, 566-67). Outsiders can also sponsor elements of a candidate's campaign (e.g., paying for a band of singers to promote a candidate or airing pro-candidate messages on TV channels, as Russia did during the 2004 Ukrainian elections). Another example is the signing of agreements and trade/aid deals close to an election, thus creating the impression of support for the current incumbent. A country could also hand an incumbent government a diplomatic victory, as Portugal did for Kaunda in the Zambian presidential elections of 1968.[14]

Examples of *process*-interventions include paying for election observation and for the organization of elections, conditioning aid on the execution of free and fair elections or threatening sanctions over fraud,[15] calling for the repeal of discriminatory legislative acts,[16] paying to train political parties in democratic practices. To take one example of the latter, consider a Morocco-targeted program by the National Democratic Institute (NDI) and the International Republican

[13] Also, our framework can apply to the case of non-state actors, influencing substate (federal) elections.

[14] Incumbent President Kaunda was thought to be much more moderate than Zambia's vice-president, whose supplanting of Kaunda as leader would risk turning Zambia into 'the spearhead of black Africa's war of attrition against white-governed southern Africa'. Portugal mounted pressure on Rhodesia's Smith regime to settle the dispute with Great Britain over independence as a means to secure the Zambian elections in favor of President Kaunda. A. J. Melville Williams, "Zambian election threat disturbs Portuguese officials," *The Christian Science Monitor*, November 30 1968.

[15] See Galtung (1967).

[16] In the run-up to the 2010 Presidential elections, the Sudanese ruling party's political mobilization secretary, Haj Majid Suwar, strongly rejected the U.S. Secretary of State's calls to suspend the national security Act as a guarantee to the freedoms of the coming elections. See "U.S. not in a position to ask for suspension of Sudan security act - Official", BBC Monitoring - Middle East, January 10, 2010.

Institute (IRI), funded by USAID, the National Endowment for Democracy (NED), and the State Department's Middle East Partnership Initiative (MEPI). This program comprised 17 separate projects from 2003 to 2010, with time-frames ranging from three months to two years and funding from \$110,000 to \$2,470,000. Project activities focused on strengthening political parties, supporting election-related activities, increasing the participation of women and youth, and strengthening locally elected officials and parliament, for a total program cost of \$12,255,699.[17] A different kind of process intervention occurred in 2007 in Bosnia. Under international pressure, campaign financing was regulated for the first time, by enforcing disclosure of donations and stipulating limits.

We should emphasize that a country can engage in more than one type of intervention at the same time – investing in candidates and processes. Finally, we do not require investments to be very effective at achieving their goals.[18] We say more about this later.

Formally, the election result becomes a function of ex-ante level of bias and ex-ante level of support, which are now affected by the investment in candidates and processes: $f(\chi(c), \beta(p)) = f(c, p)$.

(Geo-)political Concerns

The foreign power cares about the position of the incumbent on the political spectrum (A_{gov}) and about the position of the opposition (B_{opp}).[19] Since divisions between domestic factions are important for our argument, we pause to offer some examples.

According to Thucydides, democratic politics in early Hellas featured divisions on whether to ally with Sparta or Argos.[20] Both powers were keenly aware of the need for allies, and sought to influence the politics of Greek city states in order to install allies in office. Little has changed since then. Imperial Russia, and the Soviet Union, have always been interested in a belt of friendly states in Eastern Europe.[21] In some ways, this is the Russian version of the 'Monroe' doctrine the United States implemented toward Latin America. Friendly states may permit Russian bases. Friendly neighbors are also more likely to accept Russian goods and welcome investment in key value-adding areas, such as nuclear energy.

Apart from their geo-strategic objectives, sometimes, what foreign powers find objectionable abroad is more closely related to nationalism and ethnic intolerance. Elections in the successor states of former Yugoslavia often placed in office candidates with questionable commitment to

[17] The Washington Institute: Policy Brief 1282, September 6, 2007; USAID Morocco, Political Party Program Evaluation, Final Report, May 2010.

[18] Even though, at least in the case of democracy promotion, a number of scholars have suggested that outsiders can improve elections. See von Borzyskowski (2015); Collins (2009); Finkel et al. (2007); Hyde (2011); Scott and Steele (2011).

[19] Assuming that voters cannot control politicians after the election, and deriving partisan preferences from a "citizen-candidate" model of electoral races, is one way to derive durable candidate distinctions (Persson and Tabellini, 2000, Chapter 5).

[20] See Book One in Robert Stressler (1998).

[21] Ramonaite (2010) gives an example from Lithuania, where the main political divisions are on policy toward Russia and 'lustration', or stance toward cadres of the former Communist regimes. Estonia, Latvia, Ukraine, Bulgaria, Slovakia all have mainstream parties that are openly supportive of Russian interests and ones that are opposed (Bútorová and Bútora, 1998).

ethnic peace and reconciliation. Foreigners clearly worried about the ability of democracy to moderate the positions of winning candidates in the Western Balkans. Biliana Plavšić's loss in the 1998 elections in Republika Srpska came after she had adopted very pro-US positions and was characterized as the 'United States' running mate'.[22] China frets over politicians with pro-independence agendas in Taiwan.

When parties in a democracy have diverging policy positions, elections determine the relative probability these positions will result in future policy. Within the context of our model, this probability can be influenced by investment in processes and candidates.

The foreign power's level of concern with positions may vary across countries. We define a parameter $\Gamma \geq 0$ that represents a country's geo-political importance from the perspective of an outside power. A high value would, for example, be more appropriate for former colonies, for countries hosting a military base, or for countries with ethnic diasporas the intervener cares about. Higher values of the parameter Γ indicate that the difference between party positions is more consequential.

This leads us to the first component of a foreign power's utility function:

$$u^{\diamond} = \Gamma\Big[f(c,p) \times A_{gov} + (1 - f(c,p)) \times B_{opp}\Big]$$

Liberal Concerns

Research in international relations and political theory suggests that actors in world affairs may care about democracy. The possible reasons are many. They include Kantian considerations, which posit that democracies share values with each other – including pacific values (Russett, 1993). They also include considerations related to human rights (Sen, 2000) and sustained economic growth, as well as models of development (Narizny, 2007). We do not seek to explain why some states may care about democracy. We simply allow this concern to vary.

A simple way to capture a power's commitment to liberalism is to introduce a parameter Λ. The term Λ is a reduced-form representation of the types of institutional, long-run benefits a state may anticipate to arise from more democracy in another country.

We distinguish between liberal, aliberal and illiberal powers.

For liberal powers, we assume $\Lambda > 0$. Such states gain from democracy in another state.

We call states with $\Lambda = 0$ aliberal actors: they take no sustained interest in the existence or lack of stronger rules for the democratic game abroad. It is a plausible conjecture to place Qatar, possibly China, in this category.

By contrast, $\Lambda < 0$ represents illiberal states: countries that define their interests as poorly-served by strong democratic institutions abroad. Putin-led Russia may be an example of such a power.

[22] To this list of ideological divisions on foreign policy issues, one can add a medley of other examples. Competitors in South Korea voice different views on how to deal with the North. Some parties in Japan want U.S. bases closed (Okinawa). In Italy, America's Cold War containment policy (Gaddis, 1987) turned into a wholesale American support of the Christian Democrats (Nuti, 1998).

We add a word of caution. We do not assume that a country's observed actions vis-à-vis another country's elections will always reflect the sender country's genuine concern with liberalism abroad. In fact, we will show that strategic considerations may elicit democracy-promotion strategies from states that are indifferent to democracy and depress such impulses in otherwise liberally-inclined powers.

In our model, outside interventions in processes p affect the bias β. The outsider has an additional term in the utility function:

$$u^{\diamond\diamond} = -\Lambda\beta(p)$$

This term basically says that any investment $p > 0$ in bias reduction has an (intrinsic) positive effect for the liberally-minded power. We assume that investment in fairer rules of the game is an investment in institutions. Such investment will not necessarily make the target country an exemplary democracy, but it will bring the outcome closer to this ideal.

Cost Structure

When outsiders intervene, they pay a price. Fielding election observers and paying for better ballot-counting equipment, for example, are costly. Diplomatic maneuvering thus requires commitment and carries opportunity costs. In the 2010 election in Burundi, the opposition withdrew from the election due to allegations of fraud and violence in the weeks before the election. Member states of the East African Community (EAC) – Rwanda, Kenya, Uganda, Tanzania – where Burundi is also a member, visited Burundi and urged the opposition parties not to boycott the elections in order to prevent post-election violence.[23] Aiding the campaign of a candidate is costly.

Costs can go beyond (expected) expenditure and can be defined in a very broad sense. They might entail the reduction of domestic support for the intervener, at home and in the target country – and in terms of lost support in the international community.

We assume that c and p are costly, regardless of whether they work for or against the incumbent, and whether they foster democracy or go against it. The third part of the outsider's utility function, therefore, consists of two quadratic cost terms:

$$u^{\diamond\diamond\diamond} = -c^2 - p^2$$

The Intervener's Problem

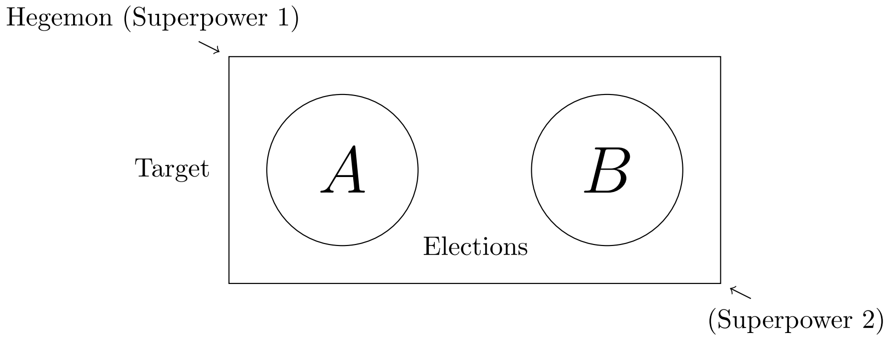
Gathering all terms, this is the utility function of the foreign power:

$$u_{int} = \Gamma\left[f(c,p) \times A_{gov} + (1 - f(c,p)) \times B_{opp}\right] - \Lambda\beta(p) - c^2 - p^2$$

[23] *Al Jazeera*, 28 June 2010.

We look at two broad, substantively important scenarios of interest (Figure 3.1): the case where one power is intervening vs. the case in which it faces an opposing actor.

Figure 3.1: The Intervention Problem



We call the one-power problem the *election hegemon* scenario. We speak of a "(regional) hegemon" if there is no other influencer present. U.S. intervention in Bolivia or the Philippines, or British intervention in Guyana are examples. "Hegemon" refers to a single intervener (or a coalition of similarly-minded actors), whereas "regional" adds to this the regional proximity of the target of interventions. In such cases, policy in target would matter a lot to the intervener (Γ is high). We call *election wars* cases where two powers, such as the U.S. and Russia may intervene on opposing sides, as they have done in Ukraine. Interveners are typically large states with substantial resources. If not, their budget limitations would constrain behavior (cf. Appendix Formal Solution of the Constrained Optimization Problem).

Domestic Conditions

Domestic conditions in the target state are captured, in a stylized form, by incumbent support χ, the measure of bias b, and the policy positions of government A_{gov} and opposition B_{opp}. These parameters enter the optimization problem of the intervener(s). We can also accommodate cost structures for the two types of electoral interventions, c and p, that differ among countries. We look at cases when investing in p is not feasible or ineffective – as would be the case in a consolidated democracy or against unwilling incumbents. We do the same for candidate investment c, which could be unwelcomed or could backfire. Our model applies primarily to recipient countries that are democratizing, but should also be relevant for countries with strong institutions.

3.3 Model Predictions

While the single-intervener case is only a decision-theoretic problem, its predictions merit some discussion because they illustrate the basic mechanisms at work in our model. This facilitates the transition to the election war case.

Before we begin, we further simplify our model by introducing the concept of political polarization. Maximizing u_{int} is equivalent to the following maximization problem:

$$\max_{c,p} \quad \pi\Gamma f(c,p) - \Lambda\beta(p) - c^2 - p^2$$

The polarization parameter $\pi = A_{gov} - B_{opp}$ measures the difference between the positions of the government and the opposition from the point of view of the outsider.[24] A positive π implies the incumbent is preferable and a negative π implies the opposition is preferable.

We choose a simple linear effect of the bias β on the election result $f(\chi, \beta) = \chi + \beta$. Absent any form of foreign intervention, a parameter value of $\beta = 0.15$ indicates an increase in the vote share by 15 percentage points at any level of support χ.

We show predictions based on a workhorse model, where we use:

$$f(c,p) = \chi + c + \left(\sqrt{b} - p\right)\left(\sqrt{b} - c\right)$$

for the vote share (the election result) and $\beta(p) = b - \sqrt{b}p$ for the resulting bias at $c = 0$.[25]

Before we present the main predictions of our model, we offer some notes on the main assumptions built into the model and the functional form. First, we should note that investment in candidates c directly affects the odds of victory, whereas investment in p is more complex – affecting who wins, but also the rules of game. The starting point of our theoretical model is a simple premise: any reduction in the bias of an election will affect the final vote count.

Second, we argue that foreign powers will often invest in candidates and processes simultaneously. In our model this is implied by the quadratic cost functions, which produce an interior solution for suitable parameter choices. This is motivated by the empirical phenomenon of increasing marginal costs (or, alternatively, diminishing returns) for specific actions or policies. Trying to achieve a marginal increase in the vote share (e.g., by increasing the turnout of the core supporters of a candidate) might be cheap at first but trying to influence large swaths of the population will become increasingly expensive.

Third, we propose a way in which investments in processes and candidates are mutually related and assume that the cost of a reduction of the bias depends on its initial level. Formally, a decrease in the bias makes the mapping between the support for a certain candidate within the electorate and the final vote share more immediate. The cost of a reduction of the bias by a certain amount depends on the initial level of the bias. This is intuitive: starting form a high bias (e.g., irregularities in the ballot counting process), reduction is less costly since better compliance could be enforced more easily (e.g. through election observers and threats of cutting aid). If the initial bias is already quite low, further improvements are more costly. For example, reducing gerrymandering or reforming campaign finance are more difficult to achieve for an outside power.

[24]For simplicity, we normalize $B_{gov} = 0$, and introduce $\pi \in \mathbb{R}$, a directional measure of polarization between the two main candidates for office on relations with the foreign power.

[25]We need $\chi \in [0,1]$, $\beta(p) > 0$ and $f(c,p) \in [0,1]$ for all feasible combinations of c and p from our choice set.

By the same token, deterioration of the voting standards (through election fraud) that start from a fair process, is assumed to be more costly than improving/deteriorating voting standards in an already biased process. An additional property of our specification is the positive effect of a bias reduction on the effectiveness of candidate support. A decrease in the bias (i.e. a positive investment in p) enhances the effect of any investment in candidate support c on the final vote share. Suppose that a foreign power promises aid to the country in case of opposition win. The voters should learn of this promise in order for it to be effective for garnering votes. It follows that the foreign power should pressure the government into providing enough freedom and media access to the opposition for the message to get across.[26]

The interaction between c and p implied by the functional form gives an additional incentive to use both means of support. But even if we would use $f(c,p) = \chi + c + \left(b - \sqrt{b}p\right)$ foreign powers would still use both – candidate and process support – if we use convex costs functions. Under alternative specifications one would find a mix between investment in c and p under a wide variety of sensible assumptions (assuming diminishing returns, some form of increasing marginal costs, etc.).[27]

3.3.1 The Hegemon Case

For the model predictions, we solve[28] the maximization problem:

$$\max_{c,p} \pi\Gamma\left(\chi + c + \left(\sqrt{b} - p\right)\left(\sqrt{b} - c\right)\right) - \Lambda\left(b - \sqrt{b}p\right) - c^2 - p^2.$$

Figure 3.2 shows analytical solutions for a set of reasonable parameter choices. This will be our basic, or "work-horse" specification: other hegemonies change some parameters, and, in our election war cases, the power with these parameters faces off another power.

We use an initial parametrization of $\Gamma = 0.75$ (i.e. target country is important) and $\Lambda = 0.5$ (i.e. liberalism matters to the outsiders). We assume (here and in what follows) that the true support

[26]In more "democratic" elections, people are more willing to cast an informed vote, based on their preferences and their knowledge about the candidates. Additionally, a high ex-ante level of the bias also makes c less effective (this is in line with the positive externality of spending on p on c).

Interestingly, this specification effectively limits the degree of bias that will be created through process interventions. Empirically, this could be motivated by a fear of negative consequences if vote rigging by a foreign intervener becomes too blatantly obvious at some point.

[27]The results we present in the following depend on our choice of cost function. We provide a short thought experiment using alternative specifications for our cost term to think about cases of $c = 0$ or $p = 0$ in the Online Appendix Alternative Cost Functions.

[28]Setting the following first-order conditions to zero identifies the optimal values of c^* and p^* in the context of our optimization problem:

$$\begin{aligned}
\frac{\partial \cdot}{\partial c} &= \pi\,\Gamma\left(p - \sqrt{b} + 1\right) - 2\,c &\stackrel{!}{=}\ 0 \\
\frac{\partial \cdot}{\partial p} &= \Lambda\,\sqrt{b} - 2\,p + \pi\,\Gamma\left(c - \sqrt{b}\right) &\stackrel{!}{=}\ 0
\end{aligned}$$

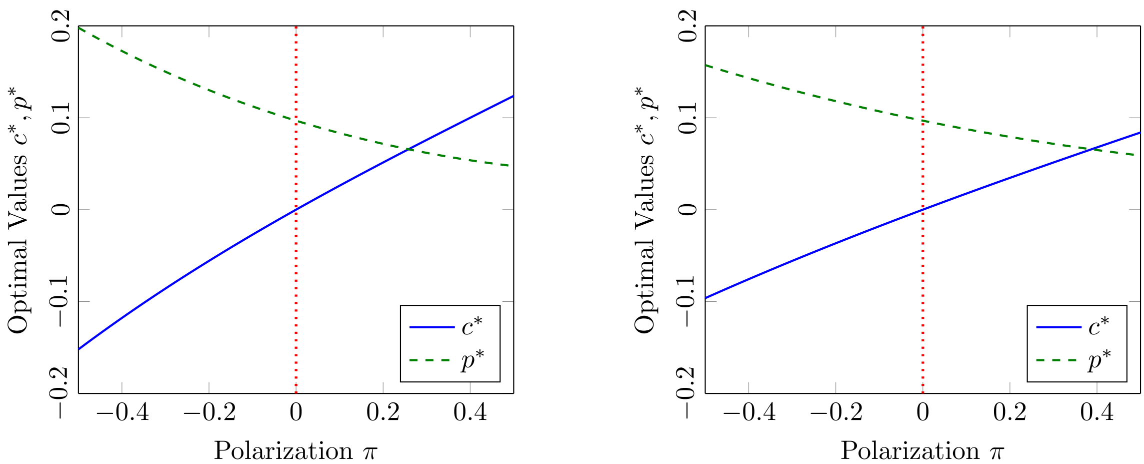
These FOCs identify a maximum, whenever $|\pi\Gamma| < 2$ (see also Appendix Solution of the Election Hegemon Problem).

is at $\chi = 0.5$ and that there exists an ex-ante bias of $b = 0.15$. Keeping those parameters in mind is important, since they provide a comparison with the non-intervention case: an incumbent win with a voteshare of $f = 0.65$, where 0.15 is from undue advantages. Outside intervention changes this counterfactual, or status quo outcome.[29]

Figure 3.2 sheds light on the extent of and sources of partisan bias in democracy-promotion.[30] Here, we compare our baseline case to the case where the geo-political importance of the target country is reduced ($\Gamma = 0.5$, Figure 3.2b) and to the case where an outside power is aliberal (i.e., unconcerned about democracy – $\Lambda = 0$, Figure 3.3).

The difference in the positions of the government and the opposition is going to predict the process/candidate mix, and the intensity of electoral interventions. This is true unless the country is geo-strategically unimportant ($\Gamma = 0$). If the foreign intervener does not care about policy outcomes at all, then there will be no candidate intervention ($c = 0$) and democracy promotion p will be set according to the degree of liberal concerns Λ. The same outcome is observed when there is no difference in the policy positions of the government and the opposition ($\pi = 0$).

Figure 3.2: Optimal Choices c^* and p^* in (Liberal) Hegemony



(a) Optimal Mix of Process and Candidate Interventions with High Stakes

(b) Optimal Mix of Process and Candidate Interventions with Lower Stakes

Thus, U.S. intervention in the Solomon Islands, a strategically unimportant country, would only be driven by a concern for liberalism. Also, in the Philippines, where "all five leading Presidential candidates are vying with one another to convince voters how much they love America and how much America loves them,"[31] our specification would predict that only process interventions would occur.

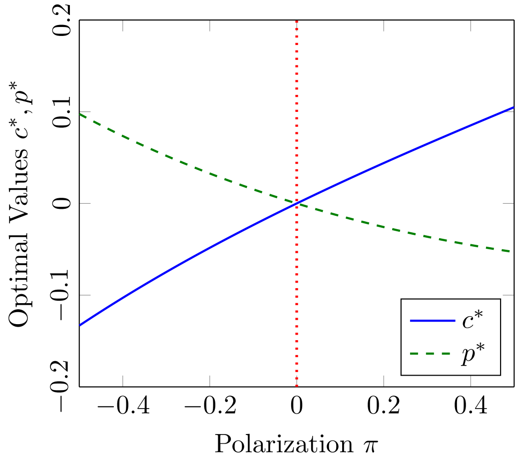
Predictions As polarization increases (the intervener prefers the incumbent in power), interven-

[29]The levels of the ex-ante outcomes are marked with a triangular symbol on the respective value of the y-axis in the Figures of vote shares and bias.

[30]On the existence of such bias, see, for example, work by Spoerri (2010) on Serbia.

[31]"All 5 Philippine Election Rivals Friends of U.S.," *LA Times*, November 10, 1957.

Figure 3.3: An Autocracy May Press for Election Integrity



ers adopt less democracy-promotion (lower p) and switch to pro-government candidate interventions ($c > 0$).[32]

As the stakes for an intervener increase (i.e., an election becomes more consequential geo-politically, Figure 3.2b to 3.2a), we see more democracy-promotion if its favored candidate is in opposition ($\pi < 0$) and less if it is in power ($\pi > 0$).[33] Thus, contrary to the view in the literature, geo-political considerations do not always erode the commitment to promote free and fair elections.

A power that attaches no intrinsic value to strengthening democracy abroad would invest in strengthening or in eroding democracy conditional on what serves its candidate (Figure 3.3). The former occurs when the sender prefers the opposition, the latter, when the sender prefers the government. One mechanism for this result is the mutual dependence of c and p. An extra unit contributed to the campaign of a friendly party will purchase more influence if the election is cleaner. Russian concerns with clean elections in post-war Finland resonate with this concern. Soviet aid for the opposition – the Communist ticket – would buy more if the playing field was more even.

On the right-side of Figures 3.2a and 3.2b , we see that a liberal foreign power may choose to offset some of its investment in cleaner processes (which hurt the incumbent), by expending more money into candidate support for its favored party. For example, officials of the Mubarak regime in Egypt were consternated by the policy of the American government to aid pro-democracy groups,

[32]Due to the proposed interaction between c and p, the intervener will only increase the bias up to a certain point, since investing in p hampers the effectiveness of candidate support. Therefore, at very high levels of $\pi >> 0$, we will see higher levels of both c and p if we further increase polarization. For the parameter choices shown in our Figures the direct effect of p on the vote share still outweighs its negative effect on the effectiveness of c.

[33]A foreign intervener that prefers the policies of the opposition ($\pi < 0$) will always spend more on democracy promotion if Γ increases. If the (liberal) intervener prefers the government ($\pi > 0$) her behavior is the following: as Γ increases and the policy outcome becomes more important relative to liberal concerns, at first, the intervener will decrease p and increase c (both in absolute terms) in order to generate additional vote shares. At high levels of spending c, however, there is an incentive to increase p in absolute terms because the level of p has an influence on the effectiveness of c.

arguing that this undermined their control over power.[34] A policy of aiding the government via loans and aid, while investing in more democratic rules, may be an optimal mix. In fact, the regime may have received more candidate support to offset pro-democracy investments.

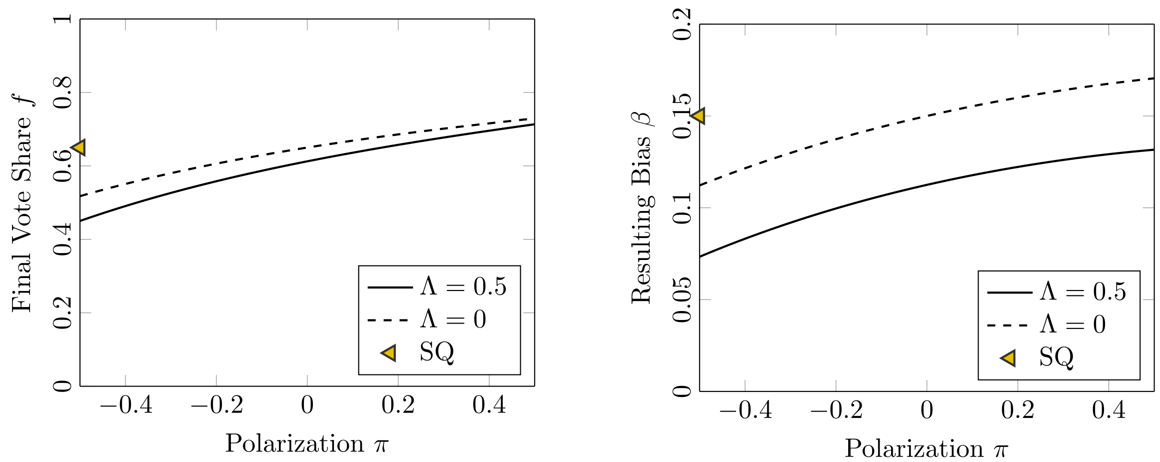
Budget

If we set a maximum amount of resources that could be spent on electoral interventions $c^2+p^2 \leq y$, then this slightly alters the optimization problem of the election hegemon. A formal solution of this case can be found in the Appendix Formal Solution of the Constrained Optimization Problem. Whenever the budget constraint is binding, the election hegemon will spend her budget on c and p proportional to the desired mix of c^* and p^* in absence of a budget constraint. A power with a small budget influences elections in a small way.

Voteshare and Bias As Hegemon Turns More Liberal

Arguably, over the last decades, the U.S. has become more committed to democracy. This motivates our next set of comparative statics. We illustrate how some quantities of interest are changed by a rise in liberal concerns from $\Lambda = 0$ to $\Lambda = 0.5$. We compare the outcomes of the scenario in Figure 3.2a with the scenario in Figure 3.3. Figure 3.4 demonstrates the impact on vote share and bias. We mark the non-intervention status quo outcome (SQ) as a reference point on how outsiders alter the domestic power game.

Figure 3.4: Outcomes of Election Hegemon Scenario



(a) Vote Shares **(b)** Resulting Bias

The changing mix of c and p interventions causes total expenditure to rise as concern with liberalism grows. This is in part a reflection of the fact that concern with liberalism justifies investment in the democratic processes. But, the effects are more subtle. In our model, investment in processes increases the payoff of investing in candidates, thereby increasing the amount spent

[34] "Charges Against U.S.-Aided Groups Come With History of Distrust in Egypt", by Scott Shane and Ron Nixon. *New York Times*, February 6th, 2012.

on one's favored party. This also means that we expect a counter-intuitive effect: a rise in liberal concerns leads to more candidate interventions. An implication is that, after the end of the Cold War, we can expect more side-taking.

Predictions Figure 3.4 shows that the growing importance of liberal norms reduce the vote share of the incumbent at any level of polarization (Figure 3.4a), primarily by reducing the unfair bias enjoyed by the government (Figure 3.4b). Still, if the foreign power likes the incumbent, due to offsetting candidate investment, this lower bias hardly hurts the vote tally.

Reducing the Effectiveness of Interventions

In consolidated democracies, the domestic rules of the game may be so strong that they cannot be easily undermined (nor strengthened). Or, it may be the case that the target government refuses democracy promotion (as Iran would do to the U.S.), or accepts only a blunted, non-threatening version (Bush, 2012). There might also be local actors that capture democratic aid, and undermine its intended effects (Jamal, 2007). One way to model these concerns in our framework is to imagine that the investment in p becomes progressively less effective, until its impact is reduced to 0. Parameter $\rho_p \in [0, 1]$ captures the effectiveness of a unit investment in democracy.[35]

We can do the same for candidate interventions. While the targeted candidate always wins additional votes from increased spending towards her campaign, there might be other reasons (outside the realm of our model) that prevent her from receiving support from a foreign intervener. One possibility is concern for corrupt allocation of finances or concern for nationalist backlash. Thus, the effectiveness of c may converge toward 0 (again, variation in effectiveness can be captured by a parameter $\rho_c \in [0, 1]$).[36]

Predictions Figure 3.5a shows us the impact of reducing the effectiveness of c. Due to the missing interaction of investment in processes p and candidates c, we see that the foreign power will actually invest weakly less into democratization if candidate support is ineffective (Figure 3.5a). Overall, prohibiting candidate support makes electoral intervention much more costly for the election hegemon since she can only influence the result by a change in the rules.[37] This decreases the effect of polarization in the target country on the final vote share of the election.

Figure 3.5b is another illustration of the interaction between p and c: positive investment in p gives the electoral hegemon an incentive to invest more (in absolute value) in candidates. If we

[35] The optimization problem becomes:

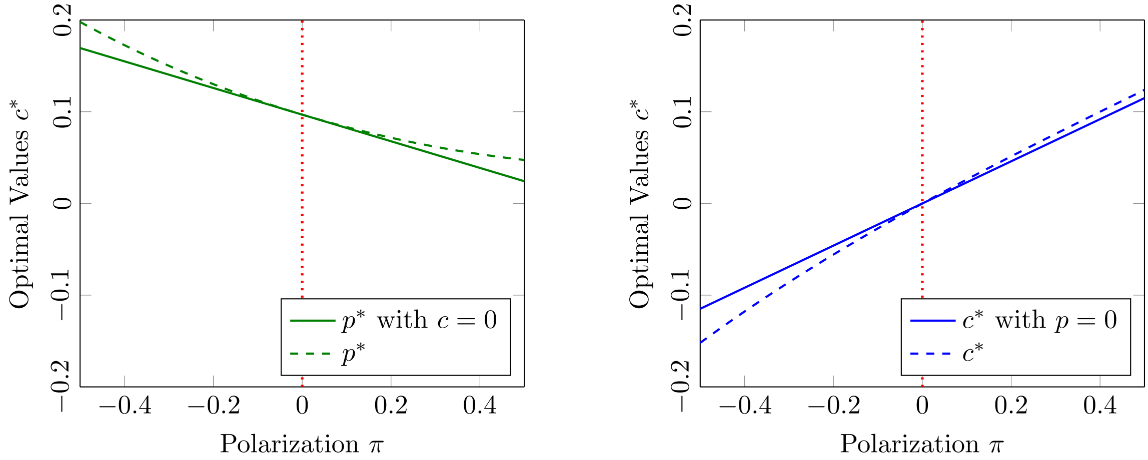
$$\max_{c,p} \quad \pi\Gamma\left(\chi + c + \left(\sqrt{b} - \rho_p p\right)\left(\sqrt{b} - c\right)\right) - \Lambda\left(b - \sqrt{b}\rho_p p\right) - c^2 - p^2, \text{ with } \rho_p \in [0, 1]$$

[36] We formalize this in the following way:

$$\max_{c,p} \quad \pi\Gamma\left(\chi + \rho_c c + \left(\sqrt{b} - p\right)\left(\sqrt{b} - \rho_c c\right)\right) - \Lambda\left(b - \sqrt{b}p\right) - c^2 - p^2, \text{ with } \rho_c \in [0, 1]$$

[37] An intervener would set c to 0 if they anticipate blowback.

Figure 3.5: Changing the scope of intervention (Liberal Hegemon)



(a) Candidate Support is prohibited **(b)** Process Support is prohibited

set $p = 0$, the liberal hegemon will invest weakly less in candidates (in absolute values), because there is no additional "boost" through candidate support.

While they might be motivated by different concerns, there is a mutually enforcing relationship between the two of them. For the election war scenarios that we introduce next, one would come to similar conclusions for a reduction of the effectiveness in spending on processes or candidates.[38]

3.3.2 Election War

The setup so far adequately captures some empirical cases. But, it would not deal satisfactorily with the emerging problem of competition with powers that are not committed to democracy (Ambrosio, 2008; Risse and Babayan, 2015; von Soest, 2015). Scholars have coined the term "black knights" for powers entering a conflict between an incumbent government and an outside actor in order to support the incumbent. When the conflict is an election, a black knight may alter the dynamics of the competition between government and opposition.

We next introduce a simultaneous move game, where two powers invest in elections. We call these scenarios "election wars" to emphasize the potentially conflictual nature of the interaction. The term also suggests that elections can be "proxy wars". Much like during the Cold War, the U.S. and the Soviet Union would not combat each other directly, but used other arenas and players to fight indirectly. Elections can be thought of as a proxy conflict over influence. The U.S. could be considered to be (the liberal) power in the models that follow.

If both powers mutually support one side/party, or if the opposing side has a considerably smaller budget or smaller stake in the election, then the problem becomes a special case of the hegemony problem from the Section The Hegemon Case.

[38]We would still find the patterns that are characteristic for the election war: counteracting spending on interventions. Changes in the effectiveness will simply alter the levels of spending in the two dimensions. If we completely shut down one dimension, international powers will counteract each other's spending in the remaining one.

We use the same formal specification for vote shares and bias as before, setting $c = c_- + c_+$ and $p = p_- + p_+$. The optimization problem of the respective powers becomes:

$$\begin{array}{ll} \max_{c_+,p_+} & \pi\Gamma_+ \left(\chi + c_+ + c_- + \left(\sqrt{b} - (p_+ + p_-)\right)\left(\sqrt{b} - (c_+ + c_-)\right)\right) \\ & -\Lambda_+ \left(b - \sqrt{b}(p_+ + p_-)\right) - c_+^2 - p_+^2 \\ \max_{c_-,p_-} & -\pi\Gamma_- \left(\chi + c_+ + c_- + \left(\sqrt{b} - (p_+ + p_-)\right)\left(\sqrt{b} - (c_+ + c_-)\right)\right) \\ & -\Lambda_- \left(b - \sqrt{b}(p_+ + p_-)\right) - c_-^2 - p_-^2 \end{array}$$

The Nash equilibrium of this simple two-player game is derived in Appendix Formal Solution of the Election War Case. Now investment c_+ of the power that likes the government whenever $\pi > 0$, is a response function to the choices of c_- and p_- by the power that likes the opposition. The same applies to investment in processes: the investment of the power that likes the government if $\pi > 0$ is denoted by p_+, and it is a response function to the choices of c_- and p_- by the power that prefers the opposite of the political spectrum.

The Liberal Symmetric Election War

The most straightforward election war case simply adds another power with opposite political preferences that cares equally about liberalism and assigns the same geo-political importance to the target country. We use $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$, $\Gamma_- = 0.75$, $\Lambda_- = 0.5$ and the rest of the parameters as in the election hegemon scenario.

The Nash equilibrium, derived in Appendix C.3, consists of a unique combination of c_+^*, c_-^*, p_+^* and p_-^*, at which none of the powers has an incentive to unilaterally deviate to any alternative spending pattern. Below, we discuss informally its properties.

In a symmetric election war, powers care about liberalism and therefore have aligned interests in this regard. With respect to policies, however, their preferred platforms are on opposite sides of the political spectrum. One consistent change in all war scenarios relative to the hegemon case is that the entry of a second power improves the performance of the party the hegemon dislikes. That party now has an ally. We refer to this as the "levelling effect" of conflict.

While the effects of spending toward a certain candidate will benefit one of the powers at the expense of the other, the effects of spending on processes p are more subtle. The direct effect of a bias reduction on the vote share is comparable to the effect of spending on candidates, but at the same time spending on p has certain "public good" characteristics if both powers care about liberalism. Additionally, process spending interacts with spending on candidates, which would boost its effects whenever total net spending on candidates $(c_+ + c_-)$ is non-zero. Therefore, each power has the incentive to counteract spending by the other power.

Predictions The result is a perfect standoff between the two international powers. In our baseline scenario, there is opposing investment in both candidates and processes, with $c_+ = -c_-$ and both $p_+ > 0$ and $p_- > 0$ – where p_+ is decreasing in π and p_- is increasing in π (cf. Appendix The Liberal Symmetric Election War). The reasons for opposing investment in candidates are clear and have to do with opposing preferences over platforms. Investment in processes rises for one of the powers as it falls for the other because having one's favorite candidate in opposition increases the incentive to invest in the rules, whereas having the favored candidate in government lessens that. There is positive net spending on p ($p_+ + p_- > 0$), because both parties care about liberalism.

A change in polarization does not affect the overall sum of spending on candidates and processes by the two powers. Therefore, the election result does not depend on polarization and for most levels of polarization voters benefit from a lower election bias compared to the election hegemon.[39]

Prior work suggests that when liberal states hold a preponderance of power in world affairs, this encourages democratization (Huntington, 1991; Boix, 2011). This proposition rests on many causal arguments, one of which is international commitment to free elections. In the previous section, we showed that when power is commanded by a single democratic hegemon, its commitment to democracy depends on the stakes, polarization, and who is in power. However, when one liberal power is pitted against another, the result is always cleaner elections.[40] Thus, we clarify the logic of liberal preponderance that leads to democracy by showing that some conflicts among foreign powers may benefit elections.

The Asymmetric Election War

Next, we introduce two types of asymmetries, in the stakes and in commitment to liberalism. We also clarify how our propositions may be tested.

First, we consider the asymmetric election war case, in which a liberal outside power (+) competes against another power (−) with more at stake in the target country, i.e. a higher Γ. We vary this parameter to offer a sense of how this changes the results. At the same time, the second power is indifferent to, or even hostile towards, democracy. Recall that we call a power indifferent to democracy "aliberal" and a power hostile to democracy "illiberal".

Predictions Figure 3.6 illustrates the predictions.[41] For the case of a contest with a power indifferent to democracy ($\Lambda_- = 0$), Figures 3.6a and 3.6b show opposing candidate investment, and opposing, but overall positive, investments in processes. Since one of the powers has more at stake in the target country, its total spending will always slightly exceed spending by the other power. Note that spending on p has no "public good"-characteristics from the perspective of the "−"-power in this case. Additionally, spending by an aliberal power will be completely "opportunistic", i.e. solely guided by the policy preferences of the power.

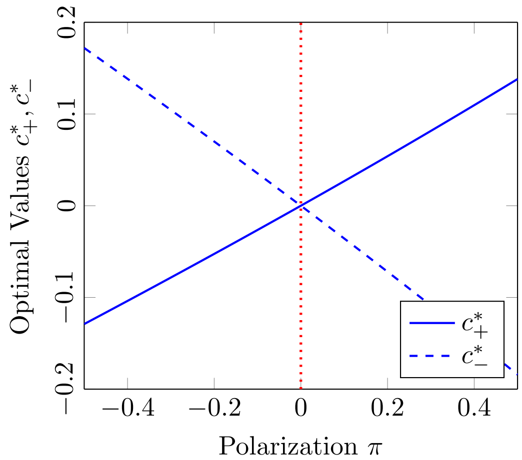
In an election war between a liberal and an illiberal power ($\Lambda_- < 0$), just as before, both investments in candidates and in processes are competing (cf. Figure 3.6c and Figure 3.6d), but the overall bias might even increase compared to its ex-ante level b through the intervention of the powers. For example, when the illiberal power likes the government in a polarized setting (the left-hand side of Figures 3.6e and 3.6f), it invests heavily against democracy and for its candidate.

[39]Recall that (on Fig. 3.4b) the degree of bias reduction is a function of polarization in the hegemon case.

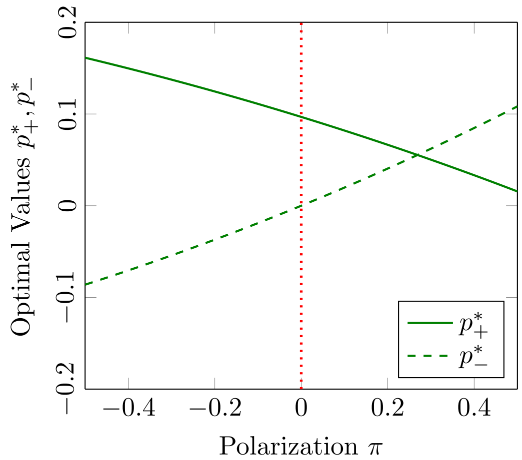
[40]Making the stakes asymmetric leaves this result intact.

[41] Figure 3.6 is based on the differences between a case with $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$ vs. $\Gamma_- = 1$, $\Lambda_- = 0$ (asymmetric, liberal/aliberal conflict) and a case with $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$ vs. $\Gamma_- = 1$, $\Lambda_- = -0.5$ (asymmetric, liberal/illiberal conflict).

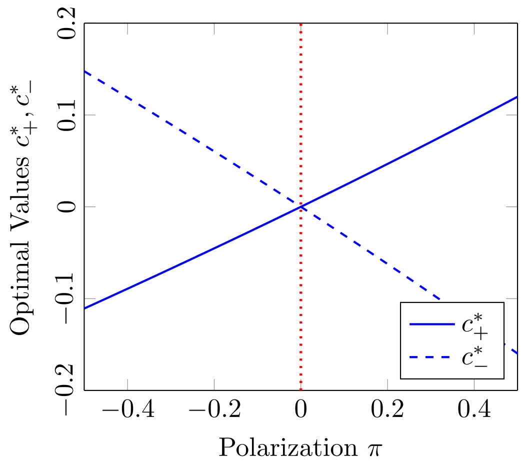
Figure 3.6: Equilibrium Choices in Election War against a Higher-Stakes Power



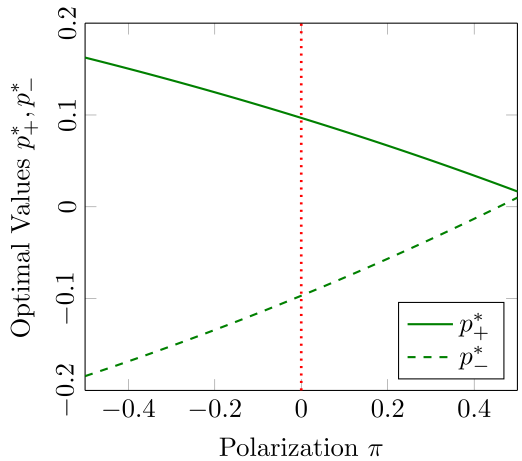
(a) Aliberal Power: Investment in Candidates



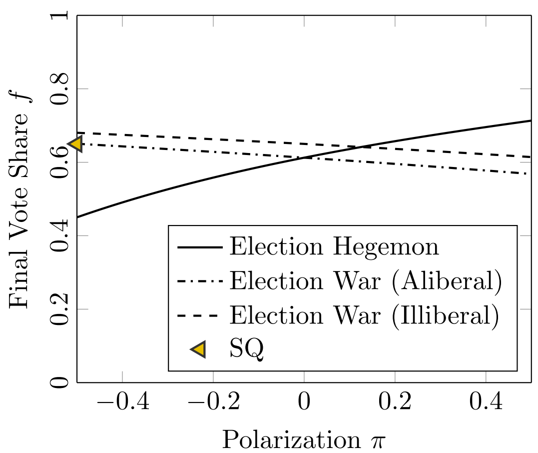
(b) Aliberal Power: Investment in Processes



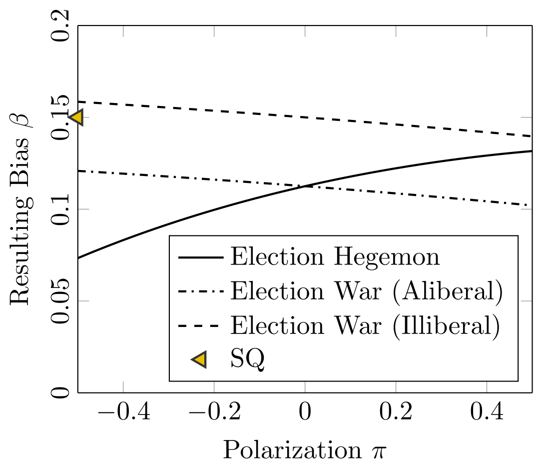
(c) Illiberal Power: Investment in Candidates



(d) Illiberal Power: Investment in Processes



(e) Comparing Vote Share



(f) Comparing Bias

Because the stakes are higher for the illiberal power, its spending dominates and drives the outcome to the highest level of bias. It also leads to very good showing of the incumbent government.[42]

Note that election wars continue to have a levelling effect, so that the difference between incumbent and opposition performance is less pronounced than it would be in the hegemon case.

To show how varying the stakes matters, we next consider a similar set of cases, except the power opposing the liberal one has lower stakes in the elections ($\Gamma_+ > \Gamma_-$). Figure 3.7 illustrates.[43] Figures 3.7a and 3.7b show opposing candidate investments, and opposing, but overall positive process investments. Since the liberal power has more at stake in the target country, it will always spend slightly more than the opposing power.

An aliberal opponent is opportunistic on democracy – sometimes spending to promote it, sometimes spending to erode it.

The picture changes for the case where the opponent is an illiberal power. Most of the time investments in candidates and processes are competing in opposite directions (cf. Figure 3.7c and Figure 3.7d). Even though the liberal power is the stronger one, the overall bias might still increase from the intervention of the powers. Figures 3.7e and 3.7f show the implications for bias and party performance. The party liked by the liberal hegemon does better (Figure 3.7e), and bias is at its highest level when that party is in government (Figure 3.7f).

Case Studies

We recap some of the comparative statics we identify in election wars. Relative to the liberal hegemon case, the entry of an illiberal power leads to lower net investment in processes and more biased elections. The aliberal entry case is more nuanced. If the aliberal power likes the opposition, then it results in lower bias. In all the "war" cases, as the stakes for one power increase, the candidate favored by that power is doing better.

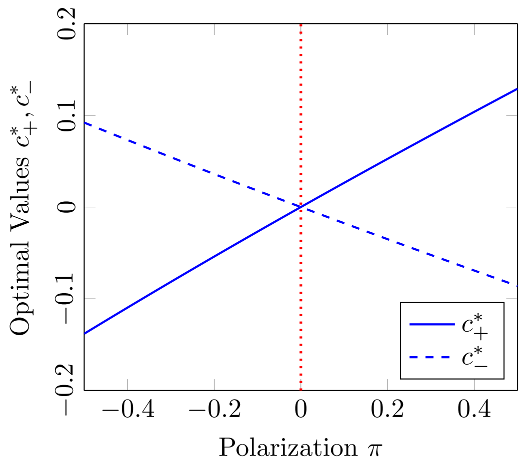
As the stakes for a power increase, there will be more investment in candidates by that power, which will only be partly counteracted by the other power. This holds in the same way for the liberal power, as well as for aliberal and illiberal powers. Investment in processes also follows the general pattern of the hegemon scenario: if the foreign power likes the opposition, there will always be cleaner elections; if the foreign power prefers the policy platform of the opposition, it will lead to lower levels of p. The implications from lower levels of p might vary across different scenarios. These implications include decreasing net positive spending on process improvements in a war against an aliberal power or further deterioration of democratic standards for the election war against an illiberal power.

Thus, we can help shed light on research on "black knights" (Risse and Babayan, 2015), which leaves open the question of whether a liberal power may counteract the election-manipulations of

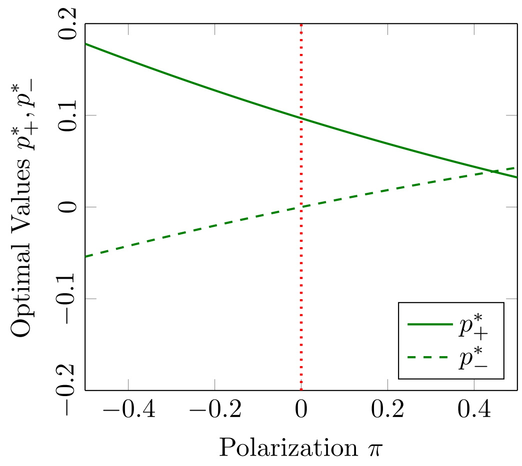
[42] As in the hegemon case, the bias will only increase up to a certain point for very high levels of polarization, or extremely high stakes.

[43] Figure 3.7 is based on the differences between a case with $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$ vs. $\Gamma_- = 0.5$, $\Lambda_- = 0$ (asymmetric liberal/aliberal conflict) and a case with $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$ vs. $\Gamma_- = 0.75$, $\Lambda_- = -0.5$ (asymmetric liberal/illiberal conflict).

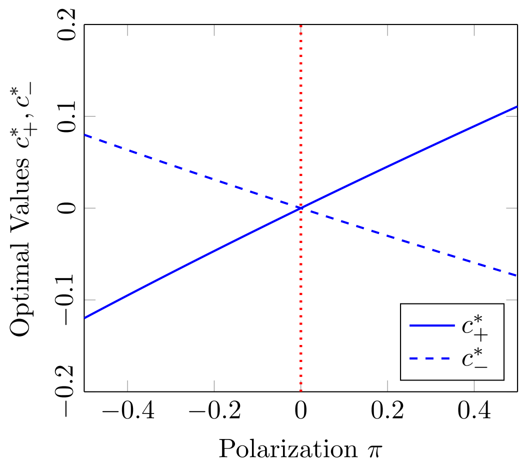
Figure 3.7: Equilibrium Choices in Election War against a Lower-Stakes Power



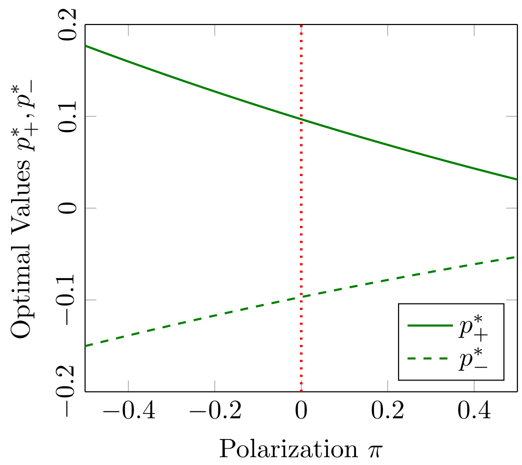
(a) Aliberal Power: Investment in Candidates



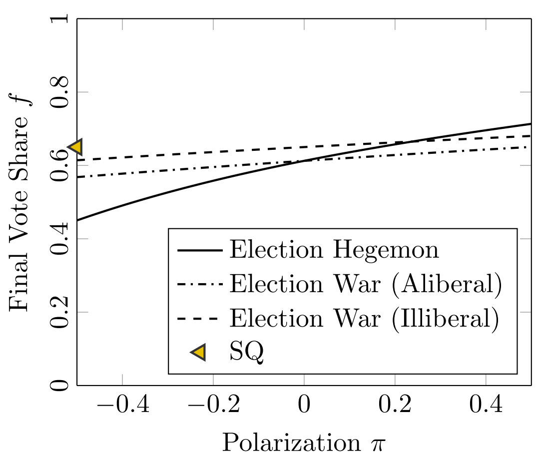
(b) Aliberal Power: Investment in Processes



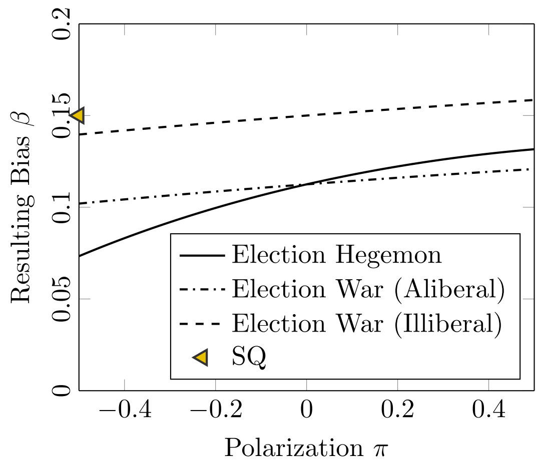
(c) Illiberal Power: Investment in Candidates



(d) Illiberal Power: Investment in Processes



(e) Comparing Vote Share



(f) Comparing Bias

the (illiberal) "black knight." An election war against an illiberal power makes it very costly for a liberal power to achieve its desired election outcomes. The impact also depends on the (relative) stakes for the two powers.

Consider Ukraine's 1991, 1994 and 2004 Presidential elections as illustrations of some of the "election war" scenarios. While domestic conditions are important, so are the interests of outsiders. Ukraine is an important country for both the U.S. and Russia. The 1991 election concluded with the election of Leonid Kravchuk, in a case where the U.S. preferred the opposition (more nationalist) candidate over Kravchuk.[44] Polarization was relatively low, since both candidates promised reforms and independence – the key issue at stake. During this period, the Soviet Union was facing significant financial difficulties and it was not necessarily opposed to the promotion of democracy. We can think of this case as an illiberal-aliberal war, or, due to the Soviet financial problems, as a case that fits the stylized description of a liberal (U.S.) hegemonic intervention.[45] Either way, based on the middle portion of the graph on Figure 3.7f, we would predict a relatively clean contest. While the election was not problem-free, election observers were satisfied with its integrity.

In the 1994 elections, Leonid Kuchma, the pro-Russian opposition candidate for President of Ukraine, defeated the incumbent Kravchuk in an election that was biased but again substantially free of significant fraud.[46] In this case, both the U.S. and Russia invested heavily in opposing campaigns: the U.S. preferred the incumbent (Kuchma) to win, whereas Russia (still relatively liberal and so, not opposed to democracy) backed the opposition.[47] This result is consistent with the right-hand side (positive π) of the election liberal-aliberal bias prediction in Figure 3.6f. Rising stakes for the aliberal power and both powers contributing some investment for cleaner processes puts the predictions of bias low, similar to the 1991 case.

In the 2004 elections, pro-Western opposition candidate Yuschenko faced significant vote-rigging. Only after mass protests that followed the second round of voting – what became known as the Orange Revolution, did he manage to win.[48] The United States pressed for democratic elections, whereas Russia helped the incumbent manipulate the electoral process. This was a case where Russia had shifted to a less liberal position in its preferences (democracy deteriorated domestically), and backed the incumbent to win. Russia had redefined its security interests in a manner that made control of Ukraine a paramount strategic objective. For the purposes of our model, bias is at the highest possible point in this context. The observed outcome – greater degree

[44]"Gorbachev puts future on line in Ukraine vote", *St. Louis' Dispatch*, December 1 1991; Lionel Barber, "Four paragraphs speak volumes for U.S. Policy", *Financial Times*, December 4 1991.

[45]The Appendix has a discussion on the impact of budget constraints.

[46]Seamus Martin, "Kravchuk is defeated in Ukraine Elections," *The Irish Times*, July 12, 1994.

[47]The election-eve announcement in Naples by President Clinton and other leaders of the seven leading industrialized nations of \$ 4.2 billion more in financial assistance furthered the impression that the West wants to see Kravchuk reelected. (See NELDA dataset, notes to variable *nelda58*).

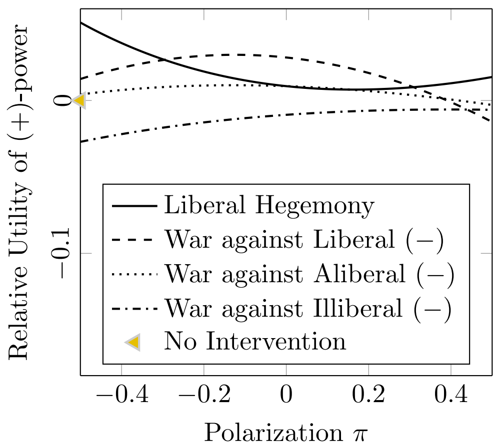
[48]Nick Paton Walsh, "Ukraine in turmoil after vote: Thousands on the streets in protest at new president" The Guardian, 23 November 2004.

of fraud – is consistent with the predictions from the model. This is illustrated on the left-hand side ($\pi < 0$) of Figure 3.6f.[49]

Superpower utility

Finally, we note that investing in the elections of others is not necessarily utility-enhancing for the outside powers. In election wars against powers that do not value – or even oppose democracy – a liberal hegemon's utility is generally low. In fact, both intervening states may be better off jointly committing not to intervene, than expending resources against each other. Thus, even where an election goes the way a superpower prefers, the victory of an election race may be of dubious value. Figure 3.8 illustrates.

Figure 3.8: Utility of the Foreign Liberal Power



3.4 Discussion

The comparative statics, illustrated across different scenarios and parameter values, provide testable propositions. We can use the geo-political importance of a country, the level of domestic polarization, and the strategic setting of one or more powers intervening, together with their commitment to liberalism, to predict incumbent win and election bias.

Testing systematically the insights of the model in elections is a matter of identifying appropriate data. Such data should include a measure of policy positions, especially ideological proximity to important international powers, and differences between the government and opposition platforms. Unfortunately, available data is either simply not at this level, or are noisy empirical approximations.[50]

[49] The Orange revolution that followed was a dramatic reaction to the perceived fraud in this case: it was the product of numerous contingent factors, and, possibly, a good amount of luck for the opposition.

[50] Consider some examples. International relations scholars use proxies, such as joint voting in the United Nations, to code close relations between countries (Voeten, 2000). By construction, this measure omits an indispensable variable to our theory: the position of the opposition. Comparative politics scholars have developed codings of party platforms. The most extensive of these is the Comparative Manifestos Project

Illustration

We construct a small dataset that tracks more closely our key variable polarization. The National Elections Across Democracy and Autocracy (NELDA) data has a number of election-level variables for more than 3300 election events (Hyde and Marinov, 2012). As a preliminary evaluation of our theory, we selected 63 election cases from NELDA and we coded whether the government and main opposition party were divided in their position on cooperation with the United States, as well as whether another power was active in the election.

We code the variable *'polarization'* in analogy to our model parameter π: *'polarization'* is 1 if the U.S. prefers the incumbent, -1 if the U.S. prefers the opposition, 0 otherwise. Conditioning variable *'war_usa'* indicates the U.S. faces an opponent, i.e., an election war scenario.[51] For the model's two outcome dimensions, incumbent vote gain and bias, we use NELDA variables *'nelda27'*,[52] and *'nelda11'*,[53] respectively.

Table 3.1 shows the mean, standard deviation and number of observations conditional on polarization and whether an election "war" or "hegemony" case (hegemony here means a case where the U.S. does not face competitors). Figure 3.9 presents the tabular information in graphical form.

Table 3.1: NELDA Data on Outcomes

	Election Hegemon (*War_usa==0*)			Election War (*War_usa==1*)		
Polarization	-1	0	1	-1	0	1
Nelda27	0.25	0.3	0.6	0.63	0.43	0.5
sd(*Nelda27*)	0.5	0.47	0.55	0.52	0.53	0.52
N	4	20	5	8	7	12
Nelda11	0.13	0.38	0.5	1	0.43	0.33
sd(*Nelda11*)	0.35	0.50	0.55	0	0.53	0.49
N	8	21	6	8	7	12

Our liberal hegemon predictions (Figure 3.2) lead us to expect better performance of the candidate(s) aligned with the U.S. and worse performance for the candidates that oppose the U.S. We also expect election bias to follow the same patterns. We see in Figure 3.9 that, when the incumbent is friendly to the U.S., i.e. the variable *'Polarization'* is coded as 1, the incumbent does better in elections. The boost is non-trivial. We also see that this is correlated with bias (in favor of the incumbent).

(Lehmann et al., 2016). There are two problems with this data, from our point of view: it covers mostly fully democratic elections, and it is most reliable for coding the Left-Right nexus of party divisions – which is often not the relevant division.

[51] Section Raw Data of the Online Appendix shows our cases and the raw codings.

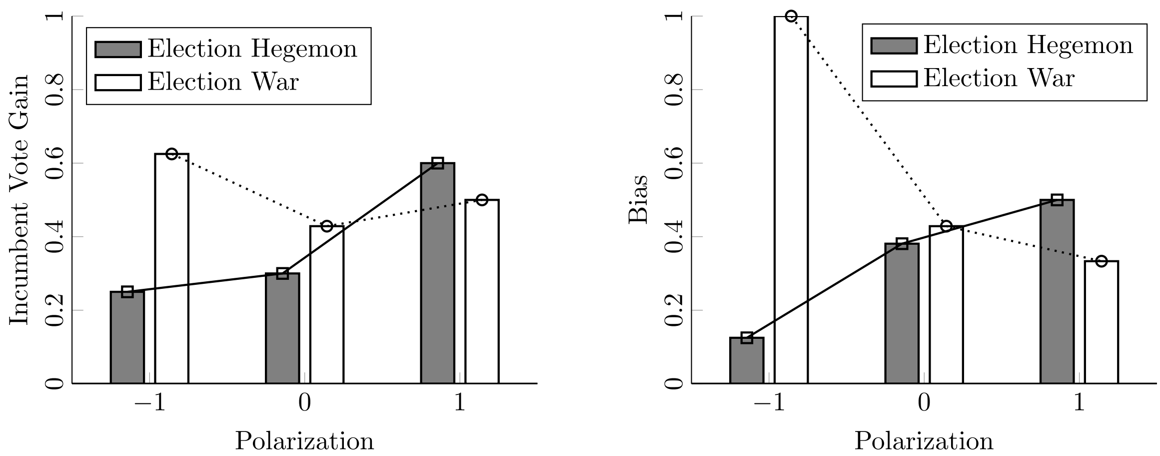
[52] The variable is a binary indicator of whether the vote count was a gain for the opposition: we subtract it from 1, to have the more relevant, gain for the incumbent (LINK).

[53] The question codes whether, before elections, there were there significant concerns that the elections would not be free and fair (LINK).

For election war cases we would expect a different dynamic (Figures 3.6 and 3.7). Whenever the U.S. is aligned with the government, the rival power is aligned with the opposition. We would expect a decrease in the effect of polarization on the vote shares (levelling effect). Figure 3.9a shows that 'wars' level the playing field and lessen the importance of being an ally to the United States (relative to the hegemony case).

From the election war cases, we see that the fraction of biased elections decreases for non-negative values of polarization $\pi \geq 0$ (Figure 3.9b). This would be consistent with a conflict between a liberal and an aliberal power, where the stakes are higher for the opposing, aliberal power – possibly due to regional interests. If the aliberal power is aligned with the opposition (and there is a pro-U.S. incumbent, i.e. $\pi > 0$) there are cleaner elections because democracy promotion is in the interest of both powers. While if the pro-U.S. party is in opposition, the U.S. is the sole power with an interest in democracy. Our theory, thus, would predict spending by the aliberal power on the deterioration of democracy for $\pi < 0$.

Figure 3.9: NELDA Data on Outcomes



(a) Incumbent Vote Gain (*Nelda27*) **(b)** Election Bias (*Nelda11*)

Our predictions are more fine-grained than the cases available for empirical examination. Future data collection can enable us to test more rigorously the model's predictions.[54] The empirical exercise suggests that external alignments are consequential for who wins elections, and how they win them. Furthermore, the effects are clearly discernible simply in the raw data.

The Effect of Democratic International Organizations

International organizations, dominated by democracies, have different ways of cajoling elites into committing to reforms and sticking with them (Pevehouse, 2002a). Unlike states, which feel compelled to prioritize geo-political agendas over democracy promotion (Reiter, 2001), international organizations can delegate the enforcement of democratic norms to specialized bureaucracies and deploy impartial election observers (Hyde, 2011).

[54]Future empirical work can also allow us to develop measures for process and candidate interventions – another set of variables utilized and predicted by the theory.

If we add to our baseline scenario a strategic outside actor that is only committed to liberalism, we can easily incorporate international organizations into our model. Since the policy outcome (which party wins) does not matter to the international organization, it will spend a constant amount p on bias reduction, regardless of political divisions. As we show in the Online Appendix The Effect of (Democratic) International Organizations, international organizations, committed to democracy, offset partisan-driven, democracy-eroding interventions in any strategic context and are always good for democracy.

Regime Overthrow

One might think of the option to decide – ex-ante – to influence a democratic regime via contributions towards candidates and processes or whether to simply attempt to overthrow the regime. In the case of Greece, for example, U.S. interventions helped nudge the political right to victory for two decades after WWII. After the left won a decisive victory in 1965, the army intervened with tacit U.S. backing (Couloumbis and Iatrides, 1980). One easy specification for this effect would be to allow overthrow at a fixed cost r and an additional cost Λ for those international powers that care about democracy. We look at this case in the Online Appendix Regime Overthrow. We show that a high degree of candidate polarization may induce the interveners to abandon interventions in elections in order to pursue supplanting democracy. The latter is more likely for an illiberal power.

Endogenous Choice of Policy Positions

Realistically, parties may change their policy positions in order to attract outside funding. Indeed, this is a possible explanation of what occurred in post-WWII Italy. National Security Advisor McGeorge Bundy complained that the ritual of Christian Democrats petitioning for money to stave off a Communist take-over – and the U.S. obliging – was America's 'annual shame.'[55] Democrazia Christiana adopted consistently, and rigorously pro-American stances, even volunteering that Italy should join NATO at an early stage. The Online Appendix Endogenous Choice of Policy Positions extends our model to allow for candidates choosing their platforms endogenously. This adds a first stage in which both the government and the opposition simultaneously determine their platforms. We present a simplified version of an exercise similar to Grossman and Helpman (1996). We show that positions shift to a larger extent and polarization grows more in the hegemon case. When both sides have an ally, there is a more level playing field and changing positions is less rewarding for attracting support that generates additional votes. The gap in the policy positions of the two parties shrinks when the party that is farther away from the outsider with higher stakes in the election finds it easier to compromise its position and adopt a more pro-foreign stance.

[55] Mistry (2006, p. 319).

3.5 Conclusion

The conceptual distinctions we develop in this paper should help further debates on democracy promotion. Observers and scholars worry that the partisan bias in U.S. democracy assistance undermines the effort's effectiveness.[56] We outline a distinction between candidate interventions (i.e., the "who" of elections) and process interventions (i.e., the "how" of elections). We argue that investments in processes and parties are mutually dependent. The value of additional investment in candidates will depend on the rules of the game. Policy polarization between candidates and the geo-political importance to the intervener determine the balance of candidate and process investments in each contest.

We contribute to work on diffusion of democracy (Gleditsch and Ward, 2006; Weyland, 2009). Scholars have asked how international forces change the conduct of elections (Rozenas, 2015; Flores and Nooruddin, 2016). We offer a more precise understanding of how the distribution of power affects electoral integrity. While interest in building institutions and in helping allies sometimes clash, we show that this is not necessarily the case. Our work on what we call election wars – conflictual investments by outsiders in different candidates – shows that outsiders sometimes bid for a paltry return and may even be better off if they could jointly commit not to intervene.

Our theoretical approach suggests avenues for further research. Empirically, we need information on how foreign actors value the opposition, not only the government. The gap in preferences for a government or opposition win has bearing on election interventions, and, via this channel, on democracy itself. Who holds power, how close relations are between states and what is the state of democracy domestically all depend on the strategic incentives of outside powers.

Theoretically, our model can be extended to cover the different manners in which foreigners "make votes count" (Cox, 1997). One could allow for more than one round to see the effects of the differing persistence of investment in candidates and processes – incorporating a quintessential feature of democratic elections: that they repeat over time. The possibility of corruption is another natural avenue for further research. Finally, our model that can be applied to domestic elections, where we can have, in a federal system, powerful lobbies square off against each other in investing in better rules or in their candidates. These and other areas of study can benefit from the theory we propose.

[56]See Stephen Krasner, "America's Role in the World: The Costs of Walking Away", USIP, Dec 11, 2011.

Appendix A

Appendix to Chapter 1

A.1 Notes on the optimal bond fund contract

In an alternative setup, the bond fund could look for a choice of d_1 that maximizes.

$$\underset{d_1}{max}\ E\left[\frac{\lambda}{1+\lambda}log(d_1)+\frac{l(d_1,d_2)}{1+\lambda}log(d_1\Theta)+\frac{1-l(d_1,d_2)}{1+\lambda}log(d_2)\right].$$

The bond fund needs to take into account the distribution of Θ and the influence of its choice of d_1 on withdrawals. The payoff d_2 will be endogenously determined by the fraction of withdrawals l, the fund's cash holdings and the price schedule of fund assets.

Given two payoffs d_1 and d_2, the expected fraction of withdrawals is equal to the ex-ante probability that a particular agent prefers to withdraw:

$$E\left[l(d_1,d_2)\right]=P\left(log(d_1\cdot \boldsymbol{P}_i)>log(d_2)\right)=P\left[\frac{\alpha\bar{\theta}+\beta x_i}{\alpha+\beta}>log(d_2)-log(d_1)\right]$$

Where $log(\boldsymbol{P}_i)=\rho_i=\frac{\alpha\bar{\theta}+\beta x_i}{\alpha+\beta}$ is a transformation of the agent's updated information, after receiving a private signal $x_i=\theta+\varepsilon_i$:

$$\begin{aligned} E\left[l(d_1,d_2)\right] &= P\left[\theta+\varepsilon_i>\tfrac{[log(d_2)-log(d_1)](\alpha+\beta)-\alpha\bar{\theta}}{\beta}\right] \\ &= 1-\Phi\left[\frac{[log(d_2)-log(d_1)](\alpha+\beta)-(1+\alpha)\bar{\theta}}{\sqrt{\frac{\beta(\alpha+\beta)}{\alpha}}}\right] \end{aligned}$$

And then, since $\theta\sim N(\bar{\theta},1/\alpha)$, $\varepsilon_i\sim N(0,1/\beta)$ and the assumption that ε_i is independent of θ, their sum is normally distributed with $\theta+\varepsilon_i\sim N(\bar{\theta},1/\alpha+1/\beta)$.

I could assume that the fund prepares for withdrawals with cash holdings of $[\lambda+\bar{l}]d_1$, where $\bar{l}$ could equal the expected amount of cahs holdings needed in order to be right on "average". However, if cash holdings do not suffice to serve withdrawals, i.e. $l>\bar{l}$, a fraction of the fund's bond holdings will have to be liquidated. The second period payoff becomes:

$$d_2 = \frac{\left(1+\lambda-[\lambda+\bar{l}]d_1 - \frac{[l(\cdot)-\bar{l}]\cdot d_1}{p(l)}\right)R}{1-l(\cdot)}$$

The function $p(l)$ describes the price schedule of bonds on the secondary market. Furthermore, if $l < \bar{l}$:

$$d_2 = \frac{\left(1+\lambda-[\lambda+\bar{l}]d_1\right)R + [\bar{l}-l(\cdot)]\Theta}{1-l(\cdot)}$$

Note that if the fund holds excess cash during the second period, it needs to be stored in a technology that is affected by the level of monetary policy Θ. In absence of specific assumptions on the pricing function $p(l)$, the fund might go bankrupt after the first period. This will happen if the fund cannot generate enough revenue to pay d_1 to all first-period withdrawers with mass $\lambda + l(\cdot)$.

In the bankruptcy case the fund will distribute all its resources among first-period withdrawers. The payment they receive will be:

$$d_1' = \frac{[\lambda+\bar{l}]d_1 + \frac{1+\lambda-[\lambda+\bar{l}]d_1}{p(l)}}{\lambda+l(\cdot)}$$

The fraction of early withdrawals $\hat{l}$ that leads the fund to go bankrupt would be the l that solves $d_1' = d_1$. For values of $l > \hat{l}$, the fund goes bankrupt and second period withdrawers receive nothing, i.e. $d_2 = 0$.

An alternative assumption would fix cash holdings at a level of λd_1. This means that fund assets have to be sold in any case, for $l > 0$:

$$d_2 = \frac{\left(1+\lambda-\lambda d_1 - \frac{l(\cdot)\cdot d_1}{p(l)}\right)R}{1-l(\cdot)}$$

Again, there is a the bankruptcy option with $d_2 = 0$ and $d_1' = \frac{\lambda d_1 + \frac{1+\lambda-\lambda d_1}{p(l)}}{\lambda+l(\cdot)}$. This is a slightly simpler payoff function and the bankruptcy option could be avoided via additional assumptions on d_1 and $p(l)$, or alternatively by imposing an upper limit on l.

A.2 Proof: No asymmetric equilibria

In Section 1.3.4 I have shown that there is a unique symmetric equilibrium in switching strategies if $\kappa\sqrt{\gamma} < \sqrt{2\pi}$. It remains to be shown that there can be no other, hence asymmetric, equilibrium. I will set $\kappa = 1$ without loss of generality and use an argument sketched by Morris and Shin (2001) and used in a similar form in Morris and Shin (2004).

I will denote by $u^n(\rho, \hat{\rho})$ the expected payoff of not withdrawing upon receiving posterior ρ, when the other players use a switching strategy around $\hat{\rho}$. Using my arguments from above, I can denote the probability, that, given some investor receives a posterior of ρ, any particular other investor withdraws because she received a signal that implies a posterior larger than $\hat{\rho}$ by:

$$\begin{aligned} P(\rho' > \hat{\rho}|\rho) &= P\Big(x' > \hat{\rho} + \tfrac{\alpha}{\beta}(\hat{\rho} - \bar{\theta})\Big|\rho\Big). \\ &= 1 - \Phi\Big(\sqrt{\tfrac{\beta(\alpha+\beta)}{\alpha+2\beta}}\Big(\Big(\hat{\rho} + \tfrac{\alpha}{\beta}(\hat{\rho} - \bar{\theta})\Big) - \rho\Big)\Big) \\ &= 1 - \Phi\Big(\sqrt{\gamma}\Big(\hat{\rho} - \bar{\theta} + \tfrac{\beta}{\alpha}(\hat{\rho} - \rho)\Big)\Big) \end{aligned}$$

Therefore $u^n(\rho, \hat{\rho})$ is given by

$$u^n(\rho, \hat{\rho}) = r - \Big(1 - \Phi\Big(\sqrt{\gamma}\Big(\hat{\rho} - \bar{\theta} + \frac{\beta}{\alpha}(\hat{\rho} - \rho)\Big)\Big)\Big),$$

where ρ indicates the posterior and $\hat{\rho}$ the threshold I expect others to use in their equilibrium strategy.

I can easily verify that $u^n(\rho, \hat{\rho})$ satisfies the following three properties:

Monotonicity: Since $\Phi(\cdot)$ is a monotonously increasing function, u^n is decreasing in the first argument (i.e. ρ) and increasing in the second argument (i.e. $\hat{\rho}$).

Continuity: u^n is continuous.

Full range: For any $\hat{\rho} \in \mathbb{R} \cup \{-\infty, \infty\}$, $u^n(\rho, \hat{\rho}) \to r - 1$ as $\rho \to -\infty$, and $u^n(\rho, \hat{\rho}) \to r$ as $\rho \to \infty$

The intuition behind the monotonicity argument is the following: For a given running threshold of the other agents, observing a higher ρ makes a run more likely and therefore reduces the expected payoff of not withdrawing. On the other hand, given I observe ρ, assuming a higher running threshold $\hat{\rho}$ for the other agents means that a run becomes less likely and therefore the expected payoff increases.

Withdrawing simply rends $u^w(\rho, \hat{\rho}) = \rho$ in expectation, independent of the actions taken by the other players. For sufficiently large ρ, withdrawing is always a dominant action. Let us denote by $\bar{\rho}^1$ the value of the belief at which withdrawal is the dominant action (i.e. $u^n(\bar{\rho}^1, \infty) = \bar{\rho}_1$). Then the depositor will always withdraw for all values of $\rho > \bar{\rho}^1$.

It is therefore rational to rule out strategies that assume that other depositors will leave their money with the fund for values of ρ larger than $\bar{\rho}^1$. But then, investors will always run if the posterior is higher than $\bar{\rho}^2$, where $\bar{\rho}^2$ solves:

$$u^n(\bar{\rho}^2, \bar{\rho}^1) = \bar{\rho}_2$$

By monotonicity it holds that $\bar{\rho}^2 < \bar{\rho}^1$. A switching strategy around $\bar{\rho}^2$ is a best response to a switching strategy around $\bar{\rho}^1$ and there exists no reasonable belief for a switching threshold larger than $\bar{\rho}^1$.

In the next round I can eliminate all switching strategies larger than $\bar{\rho}^2$. This leads to a decreasing sequence of switching values

$$\bar{\rho}^1 > \bar{\rho}^2 > \ldots > \bar{\rho}^k.$$

Due to the monotonicity properties of $u^n(\cdot)$, the largest solution $\bar{\rho}$ of the equation $u^n(\rho, \rho) = \rho$ is the largest lower bound of this sequence, and hence its limit. Any strategy that does not imply a withdrawal for $\rho > \bar{\rho}$ does not survive the iterated elimination of dominated strategies.

There is an analogous argument that demonstrates that not withdrawing at values of ρ that are smaller than the smallest solution $\underline{\rho}$ of the equation $u^n(\rho, \rho) = \rho$ can be ruled out by an iterated elimination of dominated strategies argument.

Since I have shown in section 1.3.4 that the equation $u^n(\rho, \rho) = \rho$ has a unique solution, it holds that $\bar{\rho} = \underline{\rho}$ and hence this is the unique equilibrium surviving the iterated elimination of dominated strategies.

A.3 Derivative of γ with respect to α and β

I have defined γ as:

$$\gamma = \frac{\alpha^2(\alpha + \beta)}{\beta(\alpha + 2\beta)}$$

Taking the derivative with respect to α:

$$\frac{\partial \gamma}{\partial \alpha} = \underbrace{\frac{\alpha}{\beta(\alpha + 2\beta)^2}}_{>0} \underbrace{\Big[(\alpha + 2\beta)(3\alpha + 2\beta) - \alpha(\alpha + \beta)\Big]}_{>0 \text{ (see below)}} > 0$$

Since both α and β determine variances it has to hold that $\alpha > 0$ and $\beta > 0$. This means I can determine the sign of the sum in the squared brackets. For positive values of α and β it holds separately that $\alpha + 2\beta > \alpha$ and $3\alpha + 2\beta > \alpha + \beta$. Therefore:

$$(\alpha + 2\beta)(3\alpha + 2\beta) > \alpha(\alpha + \beta)$$

Taking the derivative with respect to β:

$$\frac{\partial \gamma}{\partial \beta} = \underbrace{\frac{\alpha^2}{\beta^2(\alpha + 2\beta)^2}}_{>0} \underbrace{\Big[\beta(\alpha + 2\beta) - (\alpha + \beta)(\alpha + 4\beta)\Big]}_{<0 \text{ (see below)}} < 0$$

For positive values of α and β it holds separately that $\beta < \alpha+\beta$ and $\alpha+2\beta < \alpha+4\beta$. Therefore:

$$\beta(\alpha + 2\beta) < (\alpha + \beta)(\alpha + 4\beta)$$

A.4 Results based on alternative measures of monetary policy uncertainty

Additional empirical results are in Tables A.1 and A.2. These are base on alternative measures of monetary policy uncertainty.

Table A.1: FOMC projections and fund flows of corporate bond funds

VARIABLES	(1) $\text{Flows}_{i;t}$ (%)	(2) $\text{Flows}_{i;t}$ (%)	(3) $\text{Flows}_{i;t}$ (%)	(4) $\text{Flows}_{i;t}$ (%)	(5) $\text{Flows}_{i;t}$ (%)
median(FOMC)_t	-1.140***	-1.958***	-2.038***	-2.038***	-2.038***
	(0.279)	(0.317)	(0.340)	(0.298)	(0.366)
range(FOMC)_t	0.253	0.725***	0.743***	0.743**	0.743**
	(0.250)	(0.260)	(0.262)	(0.320)	(0.341)
$\text{Return}_{i,t-1}$	20.10	11.90	8.355	8.355	8.355
	(12.74)	(13.26)	(13.74)	(19.84)	(20.05)
$\log(\text{TNA})_{i,t-1}$	-2.167***	-11.94***	-11.95***	-11.95***	-11.95***
	(0.241)	(1.206)	(1.209)	(1.307)	(1.366)
S&P 500_t (%)			8.660	8.660	8.660
			(7.937)	(7.534)	(7.995)
VIX_t			-0.0712	-0.0712	-0.0712
			(0.0555)	(0.0664)	(0.0682)
Observations	83,803	83,799	83,799	83,799	83,799
R-squared	0.010	0.076	0.076	0.076	0.076
Fund Fixed Effects	No	Yes	Yes	Yes	Yes
Clustered SE	i/.	i/.	i/.	./t	i/t

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.2: Federal funds futures prices and fund flows of corporate bond funds

VARIABLES	(1) $\text{Flows}_{i;t}$ (%)	(2) $\text{Flows}_{i;t}$ (%)	(3) $\text{Flows}_{i;t}$ (%)	(4) $\text{Flows}_{i;t}$ (%)	(5) $\text{Flows}_{i;t}$ (%)
SVEN1F01_t	-2.496***	-3.392***	-3.837***	-3.837***	-3.837***
	(0.371)	(0.445)	(0.500)	(0.521)	(0.593)
$\text{sd}_{21}(\text{SVEN1F01})_t$	12.77***	8.911*	10.64**	10.64	10.64
	(4.815)	(4.766)	(5.014)	(8.689)	(8.599)
$\text{Return}_{i,t-1}$	17.90	5.429	-0.798	-0.798	-0.798
	(13.25)	(13.74)	(14.22)	(18.22)	(18.58)
$\log(\text{TNA})_{i,t-1}$	-2.164***	-11.89***	-11.91***	-11.91***	-11.91***
	(0.241)	(1.204)	(1.207)	(1.303)	(1.362)
S&P 500_t (%)			3.214	3.214	3.214
			(8.070)	(7.816)	(8.137)
VIX_t			-0.142**	-0.142**	-0.142**
			(0.0557)	(0.0659)	(0.0669)
Observations	83,803	83,799	83,799	83,799	83,799
R-squared	0.011	0.076	0.076	0.076	0.076
Fund Fixed Effects	No	Yes	Yes	Yes	Yes
Clustered SE	i/.	i/.	i/.	./t	i/t

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix B

Appendix to Chapter 2

B.1 Econometric approach

For each outcome the basic model setup is the following regression specification:

$$y_{i,t} = \beta_{i,0} + \sum_{j=0}^{s} \theta_{ij} \Delta i_{t-j}^{EA} + \sum_{k=1}^{p} \beta_{ik} y_{i,t-k} + \sum_{l=0}^{q} \gamma_{il} \boldsymbol{c}_{i,t-l} + \varepsilon_{i,t}$$

The main coefficients of interest are the parameters θ_{ij} associated with the realizations of our monetary policy surprise Δi^{EA}.

B.1.1 Joint estimation of reallocation measures

Before we explain the exact choice of specification for each of the reallocation measures, we want to recall a specific property: portfolio shares sum up to 1 by definition, hence reallocation measures sum up to 0. We exploit this property in our estimation approach by imposing an additional constraint on the fitted values.

Joint estimation without a restriction

We take the dependent variable total reallocation $\Delta w_{i,t}$ with respect to fund category i and write the above equation more compactly. Instead of

$$\Delta w_{i,t} = \beta_{i,0} + \sum_{j=0}^{s} \theta_{ij} \Delta i_{t-j}^{EA} + \sum_{k=1}^{p} \beta_{ik} \Delta w_{i,t-k} + \sum_{l=0}^{q} \gamma_{il} \boldsymbol{c}_{i,t-l} + \varepsilon_{i,t},$$

we can rewrite the equation based on the vector $\boldsymbol{\Delta w}_i = (w_{i,1}, \ldots, w_{i,T})$:

$$\boldsymbol{\Delta w}_i = \boldsymbol{\delta}_i' \mathbf{X}_i + \boldsymbol{\varepsilon}_i.$$

where the matrix $\mathbf{X}_i$ contains all values of the (lagged) regressors from the vectors $\boldsymbol{\Delta i^{EA}}$, $\boldsymbol{\Delta w}_i$ and the matrix $\boldsymbol{c}_i$. We have $I = 8$ fund categories and $\boldsymbol{\delta}_i$ consists of coefficients for $K-1$ regressors and a constant. There are $t = 1, \ldots, T$ time periods. In order to jointly estimate all portfolio shares of the $i = 1, \ldots, 8$ fund categories we can rewrite, $\boldsymbol{\Delta w} = (\boldsymbol{\Delta w}_1, \ldots, \boldsymbol{\Delta w}_I) = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$ by stacking the equations using a block diagonal matrix $\mathbf{X}$ of dimension $IT \times IK$:

$$\begin{bmatrix} \boldsymbol{\Delta w}_1 \\ \boldsymbol{\Delta w}_2 \\ \vdots \\ \boldsymbol{\Delta w}_I \end{bmatrix} = \begin{bmatrix} \mathbf{X}_1 & \mathbf{0}_T & \ldots & \mathbf{0}_T \\ \mathbf{0}_T & \mathbf{X}_2 & \ldots & \mathbf{0}_T \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0}_T & \mathbf{0}_T & \ldots & \mathbf{X}_I \end{bmatrix} \begin{bmatrix} \boldsymbol{\beta}_1 \\ \boldsymbol{\beta}_2 \\ \vdots \\ \boldsymbol{\beta}_I \end{bmatrix} + \begin{bmatrix} \boldsymbol{\varepsilon}_1 \\ \boldsymbol{\varepsilon}_2 \\ \vdots \\ \boldsymbol{\varepsilon}_I \end{bmatrix}.$$

The first part of our approach equals a SUR (seemingly unrelated regressions) approach, where one would jointly estimate $\boldsymbol{\Delta w} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$ by OLS – or if certain conditions were to hold with respect to the error terms by (F)GLS. A joint estimation approach also enables us to correct standard errors for correlation in the error terms across fund categories.

Introducing the Summing-up restriction

In order to exploit that, across our $I = 8$ fund categories, total reallocation sums to zero ($s = 0$) – while portfolio weights sum to one ($s = 1$), we can rewrite the total reallocation into a certain fund category as minus the sum of the total reallocation into the other fund categories (we subtract their sum from s):

$$\Delta w_{i,t} = s - \sum_{j \neq i} \Delta w_{i,t} = s - \boldsymbol{i}'_{i,t} \boldsymbol{\Delta w},$$

where $\boldsymbol{i}_{i,t}$ is simply a vector of length IT containing $(T-1)I+T$ zeros and $I-1$ ones, which extracts the appropriate coefficents from the vector $\boldsymbol{\Delta w}$.[1] Hence for the vector $\boldsymbol{\Delta w}_i$, which contains the full time series of total reallocation towards the fund category i, we can now write:

$$\boldsymbol{\Delta w}_i = \mathbf{1} \cdot s - \mathbf{i}'_i \boldsymbol{\Delta w} = \mathbf{1} \cdot s - \mathbf{i}'_i \left(\mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon} \right),$$

where the $T \times IT$ matrix $\mathbf{i}'_i$ stacks the appropriate vector $\boldsymbol{i}'_{i,t}$ for all time periods $t = 1, \ldots, T$. Alternatively one can construct the matrix $\mathbf{i}'_i$ by joining $I - 1$ identity matrixes of dimension T and a matrix of zeros (from left to right, the matrix of zeros is at the i-th place among the identity matrices in $\mathbf{i}'_i$). In a subsequent step, we can replace the vector $\boldsymbol{\Delta w}$ with the equation $\boldsymbol{\Delta w} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$ (from the SURE approach).

[1] For a stylized example with I=3 and T=2, the appropriate vector in order to extract $\Delta w_{1,1}$ via the equation $\Delta w_{1,1} = s - \boldsymbol{i}_{1,1} \boldsymbol{\Delta w}$ would be $\boldsymbol{i}_{1,1} = (0, 0, 1, 0, 1, 0)$

Joint estimation with a restriction

Now we stack the joint estimation equation and the constraint:

$$\begin{bmatrix} \boldsymbol{\Delta w} \\ \boldsymbol{\Delta w}_i \end{bmatrix} = \begin{bmatrix} \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon} \\ \mathbf{1} \cdot s - \mathbf{i}_i' \left(\mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}\right) \end{bmatrix} = \begin{bmatrix} \mathbf{0}_{IT \times 1} \\ \mathbf{1}_{T \times 1} \cdot s \end{bmatrix} + \begin{bmatrix} \mathbf{I}_{IT} \\ -\mathbf{i}_i' \end{bmatrix} \mathbf{X}\boldsymbol{\beta} + \begin{bmatrix} \boldsymbol{\varepsilon} \\ -\mathbf{i}_i'\boldsymbol{\varepsilon} \end{bmatrix},$$

and rearrange,

$$\widetilde{\boldsymbol{\Delta w}} = \begin{bmatrix} \boldsymbol{\Delta w} \\ \boldsymbol{\Delta w}_i - \mathbf{1}_{T \times 1} \cdot s \end{bmatrix} = \underbrace{\begin{bmatrix} \mathbf{I}_{IT} \\ -\mathbf{i}_i' \end{bmatrix}}_{(I+1)T \times IT} \mathbf{X}\boldsymbol{\beta} + \begin{bmatrix} \boldsymbol{\varepsilon} \\ -\mathbf{i}_i'\boldsymbol{\varepsilon} \end{bmatrix} = \widetilde{\mathbf{X}}\boldsymbol{\beta} + \widetilde{\boldsymbol{\varepsilon}}$$

The last step shows that we can estimate a combined $KI \times 1$-vector $\widehat{\boldsymbol{\beta}}$ of regression coefficients for each fund category $i = 1, \ldots, I$ by using the transformed regression matrix $\widetilde{\mathbf{X}}$ with dimension $(IT + T) \times NK$. The following example uses the summing-up restriction with respect to fund category I:

$$\widetilde{\mathbf{X}} = \begin{bmatrix} \mathbf{I}_{IT} \\ -\mathbf{i}_I' \end{bmatrix} \mathbf{X} = \begin{bmatrix} \mathbf{X}_1 & \mathbf{0}_T & \ldots & \mathbf{0}_T \\ \mathbf{0}_T & \mathbf{X}_2 & \ldots & \mathbf{0}_T \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0}_T & \mathbf{0}_T & \ldots & \mathbf{X}_I \\ -\mathbf{X}_1 & -\mathbf{X}_2 & \ldots & \mathbf{0}_T \end{bmatrix}$$

Upon close inspection of the resulting matrix $\widetilde{\mathbf{X}}$ and the vector $\widetilde{\boldsymbol{w}}$ we can add the following intuition: in essence we exploit the summing-up restriction in order to add a $(I+1)$-th group of observations where the $\widetilde{\boldsymbol{w}}$-values are transformations of the values of the last fund category (the last T values of $\widetilde{\boldsymbol{w}}$ are obtained via $\boldsymbol{\Delta w}_I - \mathbf{1}_{T \times 1} \cdot s$) while the values in $(I+1)$-th row of $\widetilde{\mathbf{X}}$ are coming from the other groups (excluding the last group I).[2]

B.2 Model assumptions and model selection

In B.1 we have outlined our joint estimation approach for the parameters $\boldsymbol{\beta}_i$, $\boldsymbol{\theta}_i$ and $\boldsymbol{\gamma}_i$ with respect to each fund category i. This section will be dedicated to choosing the appropriate set of monetary policy surprises, lagged dependent variables and controls for the joint regressions with respect to our reallocation measures.

[2]We can therefore estimate this using a pooled regression setup (with appropriate correction of standard errors for dependency over time and across fund categories) and can replicate the matrix operations needed to get to $\widetilde{\mathbf{X}}$ and $\widetilde{\boldsymbol{w}}$ by using *collapse*, *merge* and *append* in Stata.

B.2.1 Choice of specification and model diagnosis

Let's recall our baseline estimation equation:

$$\Delta w_{i,t} = \beta_{i,0} + \sum_{j=0}^{s} \theta_{ij} \Delta i_{t-j}^{EA} + \sum_{k=1}^{p} \beta_{ik} \Delta w_{i,t-k} + \sum_{l=0}^{q} \boldsymbol{\gamma}_{il} \boldsymbol{c}_{i,t-l} + \varepsilon_{i,t},$$

We need to choose the number of lags for our surprises s, for our lagged dependent variables p and the set of (lagged) control variables contained in $\boldsymbol{c}_i$. Furthermore explain our choice of specification and the underlying assumptions.

Stationarity For our reallocation measures stationarity is not of concern, because our reallocation measures are a transformation of the first differences of portfolio weights over time. Indeed, a Dickey-Fuller test rejects the null hypothesis of a unit root for all of the fund categories.

Exogeneity assumptions We consider our monetary policy surprises as exogenous shocks. We construct them from high frequency data in order to extract the unanticipated component of announcements regarding monetary policy. Since we want to track their impact over time there might be reactions to these surprises. In order to control for other changes in relevant push- and pull-factors towards certain asset classes or geographies, we include a set of surprise indices that track surprises to (forecasts of) macroeconomic variables in different geographies: For the joint estimation, we use a surprise for emerging markets (*Datastream*: TBCESIR), for the G10 countries (GXCESIR) and lagged values of an Euro area surprise indicator (EKCESIR).

Lag choice We expect our surprises to have both a short-term impact and longer-term impact. The short-term impact should be related to asset price changes FX changes that immediately reflect new information. If we want to track the impact on active decisions we need to look at a longer horizon. We exclude ex-ante the contemporaneous lag of EKCESIR (due to possible collinearity) and would prefer to select a model with $s = p = q$, in order to quantify also the impact of the arrival of additional information.

Table B.1 shows the 10 best models by AIC with a maximum lag of 4 (we want to look a short-term impacts over a maximum one-week horizon) for each of our reallocation measures, based on the joint estimation approach and based on regressions covering our entire sample.

The table gives us some justification to look at the evolution of our reallocation measures over a one-week horizon (instant impact and four lags). In a next step we will check for serial correlation of the residuals.

Residual Analysis For the joint estimation approach Figure B.1 shows a plot of the autocorrelation in residuals by fund category. For the specification with $s = 4$, $p = 4$, $q = 4$ the remaining autocorrelation in residuals is minor.

Final choice of specification

For our main tables we will use regressions with four lags for the surprises, as well as four lags of the dependent variable and four lags for the controls.

Table B.1: Information criteria for different lag choices

	EA short-term rates					EA long-term rates				
	s	p	q	AIC	BIC	s	p	q	AIC	BIC
active_realloc	0	4	0	-58172.2	-57650	0	4	0	-58166	-57643.7
	1	4	0	-58159.6	-57579.3	1	4	0	-58157.6	-57577.4
	0	4	1	-58146.4	-57450.1	2	4	0	-58143.3	-57505
	2	4	0	-58145.9	-57507.6	0	4	1	-58140.2	-57443.9
	3	4	0	-58136.3	-57440	3	4	0	-58132.7	-57436.4
	1	4	1	-58134.1	-57379.7	1	4	1	-58131.9	-57377.5
	0	4	2	-58133.9	-57263.5	0	4	2	-58126.9	-57256.5
	4	4	0	-58126.8	-57372.4	4	4	0	-58119.3	-57364.9
	1	4	2	-58121.3	-57192.9	1	4	2	-58118.6	-57190.2
	2	4	1	-58120.3	-57307.9	2	4	1	-58117.6	-57305.3
passive_realloc_returns	0	4	0	-29354.3	-28832.1	0	4	0	-29428.1	-28905.9
	0	4	1	-29350.1	-28653.8	1	4	0	-29422.7	-28842.5
	1	4	0	-29340.7	-28760.5	0	4	1	-29420.7	-28724.4
	1	4	1	-29336.6	-28582.2	1	4	1	-29415.3	-28661
	2	4	0	-29332.6	-28694.3	2	4	0	-29413.3	-28775
	3	4	0	-29329.5	-28633.2	2	4	1	-29405.8	-28593.5
	2	4	1	-29328.3	-28516	3	4	0	-29402.2	-28705.9
	3	4	1	-29323.6	-28453.2	4	4	0	-29396.6	-28642.3
	4	4	0	-29316.5	-28562.1	3	4	1	-29394.3	-28523.9
	4	4	1	-29310.9	-28382.5	4	4	1	-29389.9	-28461.5
passive_realloc_fx	1	3	0	-37077.1	-36554.9	2	3	0	-37230.4	-36650.1
	2	3	0	-37069.8	-36489.5	3	3	0	-37220.5	-36582.2
	1	4	0	-37066.1	-36485.8	2	4	0	-37220	-36581.7
	3	3	0	-37060.3	-36422	1	3	0	-37218.3	-36696.1
	2	4	0	-37058.8	-36420.5	2	3	1	-37210.8	-36456.4
	1	3	1	-37057.2	-36360.8	3	4	0	-37210.2	-36513.8
	2	3	1	-37050.1	-36295.8	4	3	0	-37209.3	-36512.9
	3	4	0	-37049.4	-36353.1	1	4	0	-37207.8	-36627.5
	1	4	1	-37045.7	-36291.4	3	3	1	-37200.7	-36388.3
	4	3	0	-37045.1	-36348.8	2	4	1	-37199.9	-36387.5
total_realloc	0	4	0	-25138.2	-24616	1	4	0	-25237.3	-24657
	1	4	0	-25137.3	-24557	2	4	0	-25235.4	-24597.1
	2	4	0	-25131.5	-24493.2	3	4	0	-25223.4	-24527.1
	0	4	1	-25120.7	-24424.4	1	4	1	-25218.4	-24464
	3	4	0	-25119.2	-24422.8	2	4	1	-25216.3	-24403.9
	1	4	1	-25119	-24364.7	4	4	0	-25212.9	-24458.6
	2	4	1	-25113.2	-24300.8	3	4	1	-25204	-24333.6
	4	4	0	-25105.7	-24351.4	1	3	0	-25195.6	-24673.4
	3	4	1	-25100.3	-24229.9	4	4	1	-25194.1	-24265.6
	1	3	0	-25095.2	-24573	2	3	0	-25193.5	-24613.2

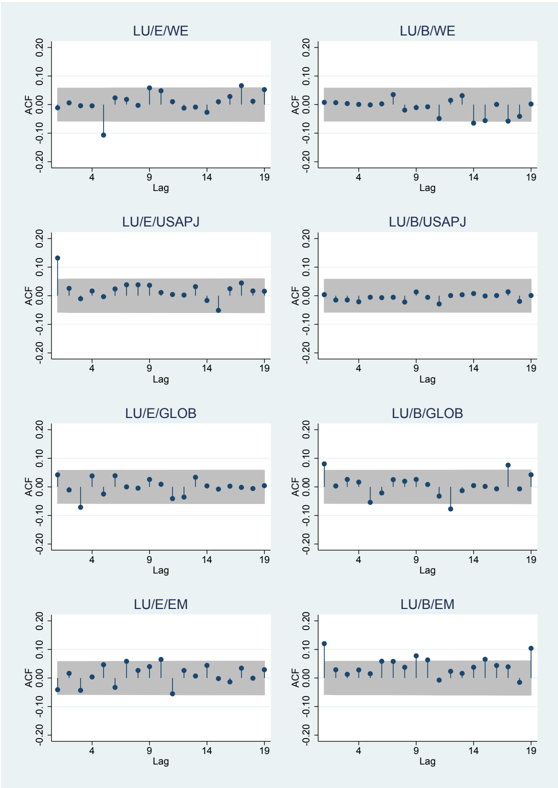
B.2.2 Specification of flow regressions

Stationarity There are no concerns regarding stationarity for flows measured at a daily frequency. A sequence of Dickey-Fuller test for each category leads to values for the test statistic below -20 (the 1% critical value being -3.43). This is a clear rejection of the H_0 of a unit root.

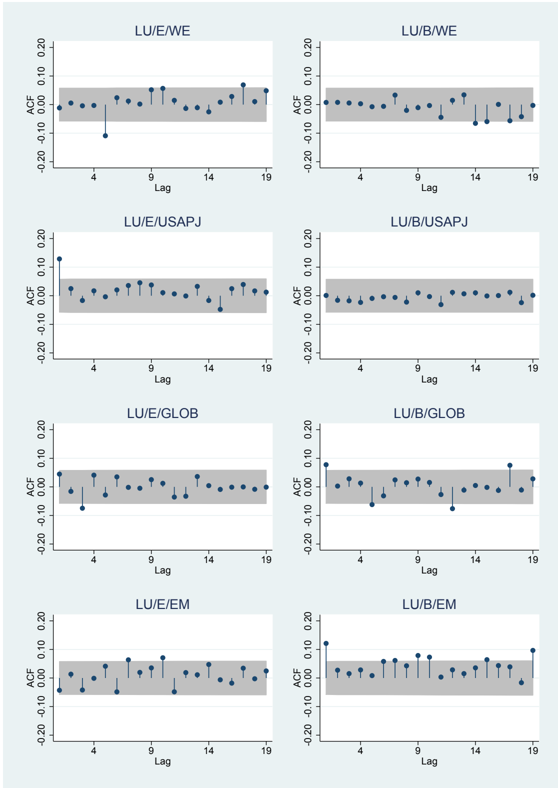
Specification The analysis of the information criteria in Table B.2 also points us towards choosing a 4-4-4 specification. Overall the pattern for flows does not differ significantly from the pattern from the joint estimation of our reallocation measures from above.

Residual Analysis If we want to avoid remaining autocorrelation in the residuals, Durbin's alternative test points us to minimum of 2 or 3 lags of the dependent variable "flows in % of TNA" that are necessary in order not to reject "H_0: no serial correlation in the residuals." The inspection of ACF plots indicates, that sometimes already 1 lag might be enough.

Figure B.1: Autocorrelation in residuals for $s = 4$, $p = 4$, $q = 4$, joint estimation (total reallocation)



(a) EA short-term rates



(b) EA 10-year rates

B.2.3 Specification of benchmark regressions

Daily returns are stationary for the currencies and benchmarks in our sample. We use the specification from the reallocation measures and the flow measures in order to be able to directly compare the relevant coefficients.

B.3 Statistical foundation of the break point

We use September 1st 2014 as a (potential) break point and report estimates of the impact of our monetary policy surprises on portfolio reallocation for the entire period, the period before and the period after the 1st of September 2014. This section will provide some statistical foundation for the choice of break point. We use two alternative approaches. The evidence in this section is based on (joint) regressions using the variable total reallocation (Δw_{it}).

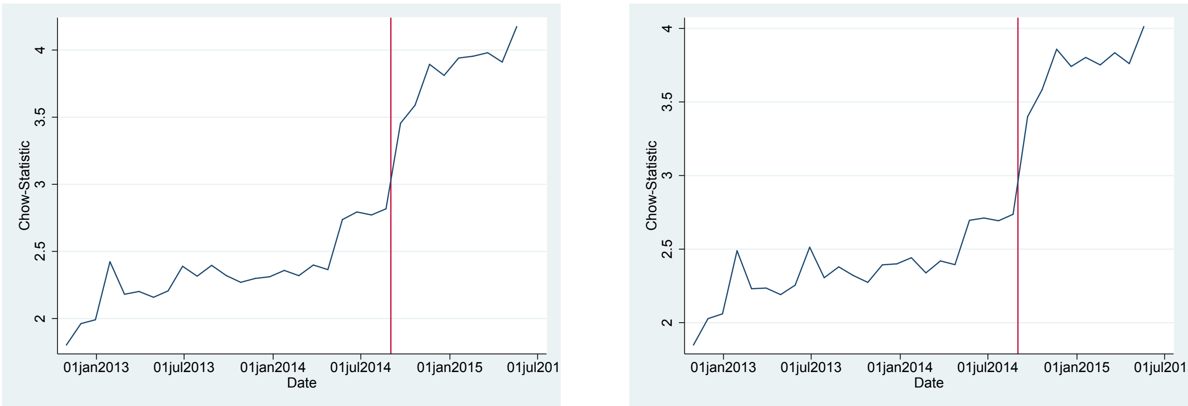
B.3.1 Chow-Test for breaks in all regression parameters

If we want to allow all our parameters to vary ex-ante vs. ex-post with respect to the break point, we can simply run a set of regressions for each possible break point candidate using the full sample, the sample before the break point and the sample after the break point. From the three regressions we separately compute their sum of squared residuals, also called the error sum of squares: ESS_{pre}, ESS_{post} and ESS_{full}. Residuals are stemming from the joint regression – i.e. the one that also includes our synthetic group that via the restriction.

$$\text{Chow-Test} = \frac{\frac{\text{ESS}_{\text{full}} - (\text{ESS}_{\text{pre}} + \text{ESS}_{\text{post}})}{k}}{\frac{\text{ESS}_{\text{pre}} + \text{ESS}_{\text{post}}}{n_{\text{pre}} + n_{\text{post}} - 2k}}$$

Intuitively the test statistic captures how much better one can fit the data by splitting the sample into two parts and running separate regressions. Our joint estimation approach estimates each parameter and constant for each group, so we will have to correct for $k = 208$ estimated parameters based on an estimation with $s = 4$, $p = 4$, $q = 4$. Then we can compare estimates over time in order to check for the maximum evidence of a break point.

Figure B.2: Chow-Test for a break in all parameters



(a) EA short-term rates **(b)** EA 10-year rates

Note: The red line indicates the break point used throughout our analysis, September 1st 2014. Altavilla et al. (2015) use this date to distinguish the effect of post-APP monetary policy from previous measures, since a series of announcements related to the preceded the official launch of this programme in January 2015.

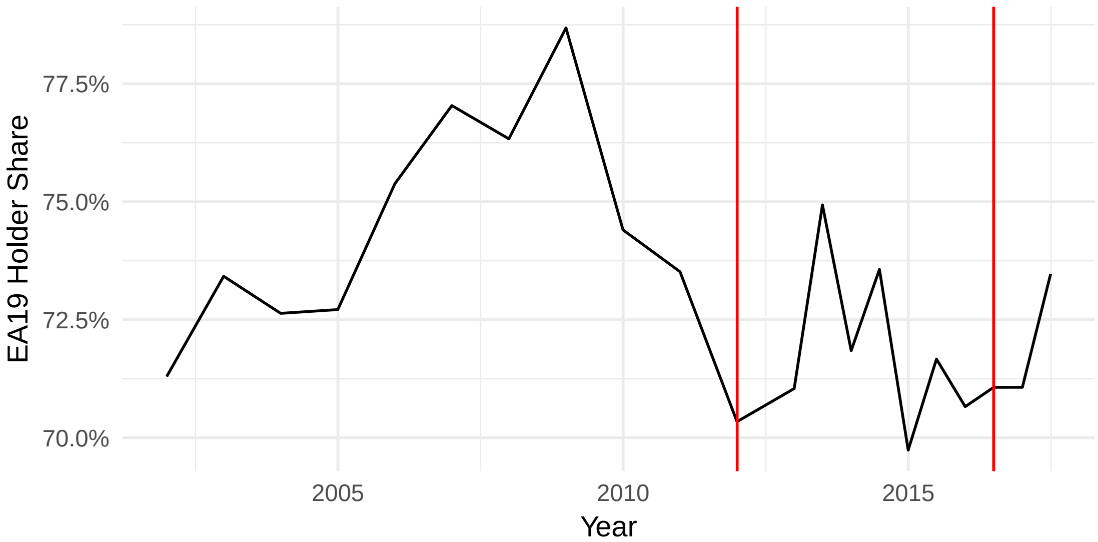
In Figure B.2 we see how the level of the Statistic changes considerably in the months leading towards the the announcement of the APP in January 2015. This provides a statistical foundation for our choice of break point. The critical value for this sequential test is different from the one for a known breakpoint, see also Hansen (2001) and Andrews (1993)

Since all parameters are free to change at the break point, the approach of this subsections gets closest to how we deal with the potential break point in our sample. By reporting regressions for the full sample, the pre-APP and the post-APP period we potentially allow parameters to change in the different episodes of the sample. If we only allow for breaks in the the effect of monetary policy surprises, the conclusions are roughly similar, pointing towards a break point in the second half of 2014.

Our evidence regarding break points points towards a single break point rather than a series of breakpoints. There are no large spikes in our Chow-statistics in the years 2012 and 2013. Nevertheless, future work based on similar data at the daily frequency might benefit from a time-varying parameter approach. In our point of view, however, splitting the sample into several (discrete) episodes characterized by a certain conduct of monetary policy fits our research question best.

B.4 Additional Figures and Tables

Figure B.3: Evolution of cross-boarder investment in Luxembourg by euro area investors



Source: Data is obtained from the IMF CPIS dataset via http://data.imf.org/regular.aspx?key=60587812. The graph shows the share of EA19 countries of the "Value of Total Investment" as reported in "Table 8: Derived Portfolio Investment Liabilities (All Economies) by Economy of Nonresident Holder: Equity and Investment Fund Shares (Derived from Creditor Data)" for Luxwembourg. The long run mean is at 73%. The mean over the sample period (marked by the two red bars) is around 72%.

Table B.2: Information criteria for different lag choices of the flow measures

	EA short-term rates					EA long-term rates				
	s	p	q	AIC	BIC	s	p	q	AIC	BIC
LU/E/WE	0	3	0	-1079.86	-1039.39	0	3	0	-1076.91	-1036.44
	1	3	0	-1078.03	-1032.5	1	3	0	-1074.97	-1029.44
	0	4	0	-1076.73	-1031.21	0	4	0	-1073.77	-1028.25
	2	3	0	-1076.05	-1025.47	2	3	0	-1073.47	-1022.88
	3	3	0	-1075.62	-1019.98	0	3	2	-1072.56	-1001.74
	0	3	2	-1075.56	-1004.73	3	3	0	-1072.03	-1016.39
	1	4	0	-1074.91	-1024.33	1	4	0	-1071.83	-1021.25
	0	3	1	-1074.12	-1018.48	0	3	1	-1071.2	-1015.56
LU/E/USAPJ	0	4	0	-1153.3	-1107.77	0	4	0	-1154.24	-1108.72
	0	3	0	-1151.71	-1111.24	1	4	0	-1153.39	-1102.81
	1	4	0	-1151.3	-1100.72	0	3	0	-1152.71	-1112.24
	1	3	0	-1149.71	-1104.18	1	3	0	-1151.98	-1106.45
	2	4	0	-1149.38	-1093.74	2	4	0	-1151.41	-1095.78
	0	4	1	-1148.25	-1087.55	2	3	0	-1149.99	-1099.41
	2	3	0	-1147.76	-1097.17	3	4	0	-1149.41	-1088.72
	3	4	0	-1147.45	-1086.75	0	4	1	-1149.25	-1088.56
LU/E/GLOB	0	3	0	-1818.75	-1778.28	0	3	0	-1819.48	-1779.01
	1	3	0	-1817.39	-1771.86	1	3	0	-1818.59	-1773.06
	2	3	0	-1815.48	-1764.89	2	3	0	-1817.66	-1767.07
	0	4	0	-1815.29	-1769.77	0	4	0	-1815.97	-1770.44
	0	3	1	-1813.89	-1758.25	3	3	0	-1815.81	-1760.16
	1	4	0	-1813.89	-1763.31	1	4	0	-1815.04	-1764.47
	3	3	0	-1813.53	-1757.89	0	3	1	-1814.59	-1758.94
	1	3	1	-1812.57	-1751.86	2	4	0	-1814.15	-1758.51
LU/E/EM	0	4	0	-1922.61	-1877.09	0	4	0	-1921.72	-1876.2
	1	4	0	-1920.7	-1870.12	1	4	0	-1920.58	-1870
	2	4	0	-1918.72	-1863.09	2	4	0	-1919.32	-1863.68
	0	4	1	-1918.57	-1857.87	0	4	1	-1917.7	-1857.01
	0	3	0	-1918.02	-1877.55	0	3	0	-1917.52	-1877.05
	3	4	0	-1917.1	-1856.4	3	4	0	-1917.4	-1856.7
	1	4	1	-1916.68	-1850.93	1	4	1	-1916.55	-1850.79
	1	3	0	-1916.11	-1870.59	1	3	0	-1916.26	-1870.73
LU/B/WE	0	4	0	-1172.33	-1126.8	1	4	0	-1172.77	-1122.19
	0	4	2	-1170.66	-1094.79	0	4	0	-1171.97	-1126.45
	1	4	0	-1170.35	-1119.77	1	4	2	-1171.41	-1090.49
	0	4	3	-1169.92	-1078.88	1	4	3	-1170.81	-1074.71
	2	4	0	-1168.89	-1113.25	2	4	0	-1170.78	-1115.15
	1	4	2	-1168.72	-1087.8	0	4	2	-1170.19	-1094.32
	0	4	1	-1168.52	-1107.83	3	4	0	-1169.81	-1109.12
	1	4	3	-1167.96	-1071.86	0	4	3	-1169.67	-1078.62
LU/B/USAPJ	0	4	0	218.1253	263.6464	0	4	0	217.7131	263.2341
	2	4	0	218.9568	274.5937	1	4	0	218.5767	269.1557
	1	4	0	220.1133	270.6923	2	4	0	220.5641	276.201
	3	4	0	220.9534	281.6482	0	4	1	221.0085	281.7032
	0	4	1	221.3768	282.0716	1	4	1	221.8693	287.622
	2	4	1	222.1991	293.0096	3	4	0	222.3914	283.0862
	4	4	0	222.9499	288.7026	2	4	1	223.8622	294.6728
	1	4	1	223.3629	289.1155	4	4	0	224.3905	290.1432
LU/B/GLOB	0	4	0	-1801.09	-1755.57	0	4	0	-1801.97	-1756.45
	0	4	1	-1799.95	-1739.25	0	4	1	-1800.73	-1740.03
	1	4	0	-1799.27	-1748.69	1	4	0	-1800.52	-1749.94
	1	4	1	-1798.07	-1732.32	2	4	0	-1799.3	-1743.66
	2	4	0	-1797.28	-1741.64	1	4	1	-1799.24	-1733.49
	2	4	1	-1796.1	-1725.28	2	4	1	-1798.07	-1727.26
	4	4	0	-1795.62	-1729.87	3	4	0	-1797.58	-1736.88
	3	4	0	-1795.28	-1734.59	3	4	1	-1796.25	-1720.39
LU/B/EM	0	4	0	-503.039	-457.518	0	4	0	-503.027	-457.506
	1	4	0	-501.79	-451.211	1	4	0	-501.192	-450.613
	2	4	0	-499.851	-444.214	0	4	1	-499.782	-439.087
	0	4	1	-499.779	-439.084	2	4	0	-499.195	-443.558
	1	4	1	-498.518	-432.765	1	4	1	-497.941	-432.189
	3	4	0	-497.933	-437.238	3	4	0	-497.298	-436.603
	2	4	1	-496.55	-425.74	2	4	1	-495.944	-425.134
	4	4	0	-495.994	-430.242	4	4	0	-495.307	-429.554

Table B.3: Correlation of the monetary policy surprises

Full sample	EA_10Y_rates	DE10YT	ES10YT	IT10YT	EA_ST_rates	EONIA (1W)	EONIA (1M)	EONIA (3M)
EA_10Y_rates	1.000	0.301	0.969	0.948	0.299	0.189	0.181	0.407
DE10YT	0.301	1.000	0.127	0.025	0.215	0.147	0.134	0.278
ES10YT	0.969	0.127	1.000	0.936	0.312	0.200	0.213	0.398
IT10YT	0.948	0.025	0.936	1.000	0.206	0.123	0.100	0.311
EA_ST_rates	0.299	0.215	0.312	0.206	1.000	0.807	0.903	0.909
EONIA (1W)	0.189	0.147	0.200	0.123	0.807	1.000	0.578	0.608
EONIA (1M)	0.181	0.134	0.213	0.100	0.903	0.578	1.000	0.751
EONIA (3M)	0.407	0.278	0.398	0.311	0.909	0.608	0.751	1.000
Pre Sept 2014	EA_10Y_rates	DE10YT	ES10YT	IT10YT	EA_ST_rates	EONIA (1W)	EONIA (1M)	EONIA (3M)
EA_10Y_rates	1.000	-0.173	0.970	0.973	0.114	0.047	0.001	0.266
DE10YT	-0.173	1.000	-0.346	-0.342	0.000	-0.015	-0.040	0.056
ES10YT	0.970	-0.346	1.000	0.952	0.171	0.093	0.079	0.297
IT10YT	0.973	-0.342	0.952	1.000	0.049	0.004	-0.055	0.189
EA_ST_rates	0.114	0.000	0.171	0.049	1.000	0.924	0.941	0.916
EONIA (1W)	0.047	-0.015	0.093	0.004	0.924	1.000	0.829	0.776
EONIA (1M)	0.001	-0.040	0.079	-0.055	0.941	0.829	1.000	0.766
EONIA (3M)	0.266	0.056	0.297	0.189	0.916	0.776	0.766	1.000
Post Sept 2014	EA_10Y_rates	DE10YT	ES10YT	IT10YT	EA_ST_rates	EONIA (1W)	EONIA (1M)	EONIA (3M)
EA_10Y_rates	1.000	0.896	0.985	0.933	0.730	0.429	0.581	0.663
DE10YT	0.896	1.000	0.875	0.699	0.588	0.350	0.419	0.574
ES10YT	0.985	0.875	1.000	0.892	0.719	0.430	0.585	0.635
IT10YT	0.933	0.699	0.892	1.000	0.730	0.418	0.601	0.652
EA_ST_rates	0.730	0.588	0.719	0.730	1.000	0.587	0.795	0.908
EONIA (1W)	0.429	0.350	0.430	0.418	0.587	1.000	0.076	0.327
EONIA (1M)	0.581	0.419	0.585	0.601	0.795	0.076	1.000	0.725
EONIA (3M)	0.663	0.574	0.635	0.652	0.908	0.327	0.725	1.000

Note: Yield changes are shown with inverted signs, such that a positive value indicates a positive surprise, i.e. a loosening of monetary policy.

Table B.4: Summary table of the EPFR dataset by fund category (Equity funds)

Description	Unit	Summary Statistics N	mean	sd	min	max
LU/E/WE						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	87.273	21.894	55.712	129.131
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.043	0.888	-5.249	3.364
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	0.013	0.163	-2.135	0.700
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	0.004	0.020	-0.193	0.082
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	0.002	0.085	-0.618	0.402
Passive reallocation (due to FX changes)	%-points	1166	-0.001	0.049	-0.379	0.390
Total Reallocation $-\Delta w_{i,t}$	%-points	1166	0.005	0.095	-0.851	0.481
LU/E/USAPJ						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	67.502	11.617	49.238	91.913
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.045	0.675	-5.591	3.062
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	-0.017	0.151	-2.113	0.671
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	-0.001	0.015	-0.198	0.061
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	0.002	0.040	-0.293	0.156
Passive reallocation (due to FX changes)	%-points	1166	0.000	0.028	-0.264	0.311
Total Reallocation $-\Delta w_{i,t}$	%-points	1166	0.002	0.049	-0.337	0.297
LU/E/GLOB						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	64.177	6.350	51.746	79.736
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.034	0.660	-5.141	2.710
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	-0.014	0.112	-1.784	0.518
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	-0.000	0.010	-0.061	0.054
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	0.001	0.030	-0.198	0.118
Passive reallocation (due to FX changes)	%-points	1166	0.001	0.036	-0.155	1.166
Total Reallocation $-\Delta w_{i,t}$	%-points	1166	0.002	0.048	-0.208	1.183
LU/E/EM						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	113.909	16.529	74.667	145.381
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.012	0.802	-5.803	3.196
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	-0.042	0.116	-2.269	0.273
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	-0.006	0.017	-0.161	0.066
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	-0.003	0.086	-0.384	0.391
Passive reallocation (due to FX changes)	%-points	1166	0.001	0.045	-0.334	0.429
Total Reallocation $-\Delta w_{i,t}$	%-points	1166	-0.008	0.096	-0.507	0.484

Table B.5: Summary table of the EPFR dataset by fund category (Bond funds)

Description	Unit	N	mean	sd	min	max
		Summary Statistics				
LU/B/WE						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	58.656	13.250	44.375	95.278
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.020	0.128	-0.676	0.766
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	0.019	0.154	-1.195	1.692
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	0.003	0.016	-0.101	0.146
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	0.000	0.053	-0.253	0.442
Passive reallocation (due to FX changes)	%-points	1166	0.002	0.061	-0.427	1.277
Total Reallocation –$\Delta w_{i,t}$	%-points	1166	0.006	0.081	-0.440	1.281
LU/B/USAPJ						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	17.713	2.059	14.886	24.810
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.012	0.122	-0.644	0.652
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	0.015	0.276	-3.524	2.730
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	0.001	0.009	-0.113	0.087
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	-0.000	0.014	-0.064	0.088
Passive reallocation (due to FX changes)	%-points	1166	-0.001	0.043	-1.366	0.540
Total Reallocation –$\Delta w_{i,t}$	%-points	1166	-0.000	0.046	-1.359	0.548
LU/B/GLOB						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	93.107	8.548	63.586	108.634
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.014	0.106	-0.716	0.430
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	-0.018	0.124	-0.630	0.904
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	-0.001	0.018	-0.088	0.198
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	-0.001	0.067	-0.246	0.506
Passive reallocation (due to FX changes)	%-points	1166	-0.003	0.050	-1.277	0.262
Total Reallocation –$\Delta w_{i,t}$	%-points	1166	-0.005	0.086	-1.263	0.518
LU/B/EM						
Total Net Assets – $A_{i,t}$	Euro (billion)	1167	51.217	6.915	39.553	69.078
Portfolio returns of the fund – $100 \cdot r_{i,t}$	%	1166	0.009	0.299	-2.441	1.588
Flows in percent of TNA – $100 \cdot f_{i,t}/A_{i,t}$	%	1166	-0.017	0.210	-2.126	2.047
Active reallocation (due to flows) – $\Delta w^{\mathrm{A}}_{i,t}$	%-points	1166	-0.000	0.016	-0.086	0.152
Passive reallocation (due to returns) – $\Delta w^{\mathrm{R}}_{i,t}$	%-points	1166	-0.001	0.029	-0.100	0.195
Passive reallocation (due to FX changes)	%-points	1166	0.000	0.017	-0.161	0.189
Total Reallocation –$\Delta w_{i,t}$	%-points	1166	-0.002	0.036	-0.151	0.215

Table B.6: Main results Euro area short-term rates (instant impact)

The table shows the (cumulative) effect associated with the surprise change in Euro area short-term rates. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 4.2 in the main text for the definition of dependent variables).

(a) Impact of a surprise change in EA short-term rates – full sample

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	0.180**	−0.051	−0.044	0.083	−0.158***	0.000	0.040	−0.060
Passive reallocation *return*	0.662	−0.115	0.162	−0.298	−0.082	0.003	−0.161	−0.121
Passive reallocation *FX*	−0.537**	0.215*	−0.000	0.530**	−0.367*	0.090	−0.101**	0.188**
Total reallocation	0.294	0.072	0.109	0.268	−0.634***	0.100	−0.219	0.035
Separate estimation (equation by equation)								
Flows (% of TNA)	1.748***	0.094	0.312	0.958	−1.029*	0.126	0.668	−0.168
Surprises	60	60	60	60	60	60	60	60
Observations	1165	1165	1165	1165	1165	1165	1165	1165
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−18.57***	14.41	20.45*	16.40	18.85**	5.18	21.69***	22.01***	21.35***

(b) Impact of a surprise change in EA short-term rates – before September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	0.130*	−0.062	−0.073	0.142	−0.204***	0.042	0.016	−0.023
Passive reallocation *return*	−0.326	−0.050	−0.266*	−0.029	0.188	0.104	0.376	0.054
Passive reallocation *FX*	−0.678**	0.260**	0.009	0.707***	−0.549***	0.123*	−0.128**	0.256***
Total reallocation	−0.881*	0.193	−0.330	0.723**	−0.558**	0.265*	0.288	0.311
Separate estimation (equation by equation)								
Flows (% of TNA)	1.526**	−0.065	0.053	1.273	−1.663***	1.094	0.441	0.015
Surprises	36	36	36	36	36	36	36	36
Observations	689	689	689	689	689	689	689	689
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−9.79***	−1.56	6.24	2.73	7.48*	1.64	11.43***	11.50***	11.16***

(c) Impact of a surprise change in EA short-term rates – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	0.291	−0.039	0.024	−0.139*	−0.018	−0.105***	0.140	−0.150
Passive reallocation *return*	3.399***	−0.285	1.294***	−1.072**	−0.810**	−0.278***	−1.690***	−0.585**
Passive reallocation *FX*	−0.243	0.147	−0.015	0.113	0.115	0.000	−0.042	−0.007
Total reallocation	3.493***	−0.171	1.285***	−1.108*	−0.761	−0.366***	−1.693***	−0.723***
Separate estimation (equation by equation)								
Flows (% of TNA)	2.248	0.302	0.828	−0.186	0.600	−2.336*	1.493	−0.997
Surprises	24	24	24	24	24	24	24	24
Observations	474	474	474	474	474	474	474	474
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−42.74***	56.18***	59.67***	53.97***	50.41***	14.89***	50.40***	50.93***	50.05***

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

Table B.7: Main results Euro area 10-year yields (instant impact)

The table shows the (cumulative) effect associated with the surprise change in Euro area 10-year yields. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 4.2 in the main text for the definition of dependent variables).

(a) Impact of a surprise change in EA 10-year yields – full sample

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.036	0.019	0.004	0.007	−0.001	0.007	0.019	−0.012
Passive reallocation *return*	0.814***	−0.043	0.246***	−0.068	−0.204***	−0.096***	−0.461***	−0.174***
Passive reallocation *FX*	−0.122	0.055	0.015	0.090	−0.064	−0.009	−0.031	0.066
Total reallocation	0.663***	0.041	0.263***	0.025	−0.277***	−0.098**	−0.478***	−0.123
Separate estimation (equation by equation)								
Flows (% of TNA)	−0.003	0.348	0.243*	0.211	0.214	0.360	0.348	0.069
Surprises	63	63	63	63	63	63	63	63
Observations	1165	1165	1165	1165	1165	1165	1165	1165
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−5.20	13.38***	9.70**	9.29**	8.28**	2.92**	6.12	6.50	6.17

(b) Impact of a surprise change in EA 10-year yields – before September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.054	0.037	0.007	0.008	0.001	0.019	−0.022	0.015
Passive reallocation *return*	0.624***	−0.058	0.100	0.053	−0.113	−0.085*	−0.347*	−0.154**
Passive reallocation *FX*	−0.060	0.027	−0.008	0.039	−0.020	−0.018	−0.040	0.072
Total reallocation	0.503*	0.070	0.097	0.099	−0.164	−0.086	−0.411**	−0.065
Separate estimation (equation by equation)								
Flows (% of TNA)	−0.149	0.480	0.265	0.217	0.225	0.644	0.066	0.397
Surprises	36	36	36	36	36	36	36	36
Observations	689	689	689	689	689	689	689	689
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
0.99	9.93***	0.90	2.61	2.50	1.24	−1.07	−0.54	−0.61

(c) Impact of a surprise change in EA 10-year yields – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.012	−0.006	0.005	−0.001	−0.011	−0.012	0.103**	−0.052
Passive reallocation *return*	1.167***	−0.008	0.469***	−0.265**	−0.378***	−0.117***	−0.677***	−0.229***
Passive reallocation *FX*	−0.192	0.069	0.046	0.163	−0.120	0.018	−0.014	0.038
Total reallocation	0.973***	0.047	0.528***	−0.121	−0.512***	−0.109***	−0.616***	−0.242***
Separate estimation (equation by equation)								
Flows (% of TNA)	0.217	0.179	0.239	0.215	0.184	−0.078	0.937**	−0.362
Surprises	27	27	27	27	27	27	27	27
Observations	474	474	474	474	474	474	474	474
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−15.76***	18.73***	24.89***	20.66***	18.68***	5.68***	18.53***	18.39***	17.89***

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

Table B.8: Main results Euro area rates (positive vs. negative surprises)

The table shows the (cumulative) effect associated with the surprise change in Euro area rates. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 3.2 in the main text for the definition of dependent variables).

(a) Impact of a surprise change in EA 10-year yields – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation (neg)	−0.080	−0.086	−0.103*	−0.050	0.261**	−0.031	0.023	0.099
Active reallocation (pos)	0.109	−0.165	0.055	0.073	0.073	−0.046	0.083	−0.259
Passive reallocation *return* (neg)	2.624***	−0.261	0.629***	0.627**	−1.200***	−0.379***	−1.646***	−0.521**
Passive reallocation *return* (pos)	4.487***	−0.276	0.342	−0.550	−1.023	−0.452**	−1.715**	−0.962***
Passive reallocation *FX* (neg)	−1.547***	0.795***	0.331**	1.062***	−1.108***	0.143**	−0.149	0.295**
Passive reallocation *FX* (pos)	−2.211***	1.365***	−0.361	1.619***	−0.902	0.213***	0.233	0.450***
Total reallocation (neg)	0.818	0.440	0.844***	1.503***	−2.038***	−0.167*	−1.996***	−0.071
Total reallocation (pos)	2.444*	0.865	0.050	0.968	−1.727	−0.178	−1.414	−1.061***
Separate estimation (equation by equation)								
Flows (% of TNA) (neg)	0.171	−0.122	−0.546	0.071	2.462**	−0.364	0.534	2.037*
Flows (% of TNA) (pos)	1.949**	−0.071	1.606*	1.708**	2.020	−0.108	1.774	−2.338
Negative Surprises	9	9	9	9	9	9	9	9
Positive Surprises	18	18	18	18	18	18	18	18
Observations	471	471	471	471	471	471	471	471
Benchmarks (neg/pos):	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−21.569***	33.528***	26.057***	31.982***	40.853***	8.099***	20.838***	23.241***	26.237***
−32.376***	45.536***	27.563*	37.824***	35.336***	7.290***	30.114***	32.931***	29.137***

(b) Impact of a surprise change in EA short-term rates – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation (neg)	0.068	−0.390	−0.287	0.225	−0.193	−0.014	0.059	0.254
Active reallocation (pos)	1.035*	−0.013	0.168	−0.145	1.027	−0.381	−1.913	−0.367
Passive reallocation *return* (neg)	6.977**	−0.084	2.162**	1.526	−3.583**	−0.913*	−4.448**	−1.378
Passive reallocation *return* (pos)	20.340***	−0.924	−1.728	−7.576*	−1.258	−1.623	−5.194	−4.745***
Passive reallocation *FX* (neg)	−3.280	1.667	0.984*	2.097	−0.485	0.303	−1.013*	0.593
Passive reallocation *FX* (pos)	−8.942	6.644	−10.459	8.026*	−12.384**	0.891*	11.478**	0.952
Total reallocation (neg)	4.578	1.043	2.544**	3.695*	−4.031	−0.495	−6.311***	−0.536
Total reallocation (pos)	12.732**	5.899	−12.054*	−0.143	−11.223	−0.585	4.469	−5.179**
Separate estimation (equation by equation)								
Flows (% of TNA) (neg)	0.849	−2.486	−2.334	0.704	−1.255	−1.635	0.605	4.098
Flows (% of TNA) (pos)	12.285***	5.103	8.055*	4.908**	17.343	−6.687	−5.745	2.780
Negative Surprises	12	12	12	12	12	12	12	12
Positive Surprises	12	12	12	12	12	12	12	12
Observations	471	471	471	471	471	471	471	471
Benchmarks (neg/pos):	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−46.165*	83.008**	55.315	69.474**	91.935**	14.710**	39.995	43.928	58.560***
−173.442***	167.271**	115.236	142.056*	81.275	24.547	148.994**	166.779***	135.214**

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

Table B.9: Results with different fund universe (impact over 4 lags)

For this table we **fix the fund universe on the 1st of January 2014** (for the remainder of the analysis we use the fund universe as of the 1st of January 2012).

The table shows the (cumulative) effect associated with the surprise change in Euro area rates. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 4.2 in the main text for the definition of dependent variables).

(a) Impact of a surprise change in EA short-term rates – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	0.204	−0.116	−0.117	−0.304	−0.164	0.186	0.127	−0.010
Passive reallocation *return*	8.023***	−0.008	1.546	−0.367	−2.522	−1.417**	−3.574**	−1.478**
Passive reallocation *FX*	−2.768**	2.658***	−0.723	2.277**	−3.316*	−0.464	1.784	1.080**
Total reallocation	6.073**	2.395*	0.548	1.500	−5.567**	−1.509	−2.344	−0.835
Separate estimation (equation by equation)								
Flows (% of TNA)	3.258	0.812	0.792	−0.904	0.815	5.682	3.235	1.251
Surprises	24	24	24	24	24	24	24	24
Observations	471	471	471	471	471	471	471	471
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−67.3***	100.8***	65.6**	74.1***	73.6*	15.2**	62.2**	68.2***	68.0***

(b) Impact of a surprise change in EA 10-year yields – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.080	−0.033	0.001	−0.003	0.153	−0.017	0.086	−0.060
Passive reallocation *return*	3.100***	−0.141	0.655***	0.372	−1.280***	−0.600***	−1.524***	−0.561***
Passive reallocation *FX*	−1.276***	0.938***	0.142	0.942***	−1.237**	0.099	0.069	0.296***
Total reallocation	1.688**	0.733*	0.796***	1.205***	−2.289***	−0.428**	−1.533***	−0.447**
Separate estimation (equation by equation)								
Flows (% of TNA)	0.167	0.297	0.507	0.551	1.462**	0.696	1.188**	−0.135
Surprises	27	27	27	27	27	27	27	27
Observations	471	471	471	471	471	471	471	471
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−25.9***	40.6***	29.5***	33.6***	38.4***	7.8***	28.3***	29.8***	28.9***

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

Table B.10: Retail vs. Institutional investors: Main results Euro area short-term rates (impact over 4 lags)

The table shows the (cumulative) effect associated with the surprise change in Euro area short-term rates. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 3.2 in the main text for the definition of dependent variables). For instance, the first coefficient on the top-left corner of the table indicates the one-week impact of the surprise change in Euro area short-term rates on the active reallocation to Western European equity funds.

(a) Impact of a surprise change in EA short-term rates – full sample

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
All Funds								
Active reallocation	0.036	−0.321*	−0.188**	0.113	−0.040	0.114	0.167	0.065
Flows (% of TNA)	0.746	−1.643	−0.382	1.260	1.223	4.046	1.264	1.135
Retail fund shares								
Active reallocation	0.274	−0.127	−0.213*	−0.026	−0.063	0.176*	−0.123	0.001
Flows (% of TNA)	2.915*	−0.260	−0.276	0.787	0.673	5.583**	−0.564	0.538
Institutional fund shares								
Active reallocation	−0.212	−0.546**	−0.136	0.206	−0.108	0.080	0.537*	0.263
Flows (% of TNA)	−0.658	−2.768	−0.067	1.686	0.111	3.799	4.709**	2.954
Additional Information								
Surprises	60	60	60	60	60	60	60	60
Observations	1162	1162	1162	1162	1162	1162	1162	1162

(b) Impact of a surprise change in EA short-term rates – before September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
All Funds								
Active reallocation	−0.210	−0.294	−0.166	−0.018	0.049	0.180	0.324*	0.065
Flows (% of TNA)	−1.346	−1.750	−0.200	0.531	1.378	5.554*	1.801*	0.430
Retail fund shares								
Active reallocation	0.143	−0.182	−0.236	−0.097	0.264	0.210*	−0.037	−0.045
Flows (% of TNA)	1.538	−0.747	−0.411	0.234	3.026*	6.008*	−0.185	−0.364
Institutional fund shares								
Active reallocation	−0.584	−0.512	−0.042	−0.104	−0.255	0.216	0.892***	0.395
Flows (% of TNA)	−3.438	−3.064	0.555	0.271	−2.446	7.751	6.647***	2.834
Additional Information								
Surprises	36	36	36	36	36	36	36	36
Observations	686	686	686	686	686	686	686	686

(c) Impact of a surprise change in EA short-term rates – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
All Funds								
Active reallocation	0.371	−0.302	−0.255	0.088	−0.080	−0.103	−0.212	0.127
Flows (% of TNA)	3.865	−0.915	−0.807	1.470	1.375	−2.975	0.212	3.691
Retail fund shares								
Active reallocation	0.377	0.126	−0.048	0.068	−0.609	0.083	−0.378	0.046
Flows (% of TNA)	3.415	1.419	0.209	0.515	−4.809	3.724	−1.845	1.400
Institutional fund shares								
Active reallocation	0.731	−0.698*	−0.556	0.162	0.408	−0.333**	−0.268	0.217
Flows (% of TNA)	6.183	−2.063	−3.243	3.438	6.714	−8.246	0.968	4.891
Additional Information								
Surprises	24	24	24	24	24	24	24	24
Observations	471	471	471	471	471	471	471	471

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

Table B.11: Retail vs. Institutional investors: Main results Euro area 10-year yields (impact over 4 lags)

The table shows the (cumulative) effect associated with the surprise change in Euro area 10-year yields. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 4.2 in the main text for the definition of dependent variables). For instance, the first coefficient on the top-left corner of the table indicates the one-week impact of the surprise change in Euro area 10-year yields on the active reallocation to Western European equity funds.

(a) Impact of a surprise change in EA 10-year yields – full sample

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
All Funds								
Active reallocation	−0.099	−0.061	0.004	0.124*	−0.019	0.010	0.043	0.015
Flows (% of TNA)	−0.207	−0.040	0.533	0.769**	−0.052	0.736	0.533	0.440
Retail fund shares								
Active reallocation	−0.024	−0.014	0.012	0.048	−0.076	0.030	0.004	0.003
Flows (% of TNA)	−0.272	−0.064	0.194	0.155	−0.861	0.868	−0.077	−0.464
Institutional fund shares								
Active reallocation	−0.183	−0.128	0.018	0.191	0.047	−0.021	0.112	−0.019
Flows (% of TNA)	−0.140	0.019	1.125*	1.471***	1.021	0.667	1.642*	0.752
Additional Information								
Surprises	63	63	63	63	63	63	63	63
Observations	1162	1162	1162	1162	1162	1162	1162	1162

(b) Impact of a surprise change in EA 10-year yields – before September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
All Funds								
Active reallocation	−0.178	−0.003	0.049	0.194**	−0.149**	0.025	0.034	0.058
Flows (% of TNA)	−1.083	0.191	0.757	0.798	−1.698***	1.146	0.259	0.638
Retail fund shares								
Active reallocation	−0.069	0.028	0.042	0.048	−0.169**	0.021	−0.027	0.068
Flows (% of TNA)	−0.955	0.080	0.166	−0.176	−2.034***	0.375	−0.602	0.346
Institutional fund shares								
Active reallocation	−0.356	−0.065	0.074	0.339**	−0.117	0.014	0.155	−0.006
Flows (% of TNA)	−1.479	0.193	1.563	1.926**	−1.080	2.352	1.844	0.743
Additional Information								
Surprises	36	36	36	36	36	36	36	36
Observations	686	686	686	686	686	686	686	686

(c) Impact of a surprise change in EA 10-year yields – after September 2014

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
All Funds								
Active reallocation	−0.002	−0.120	−0.040	0.003	0.178	−0.037	0.054	−0.047
Flows (% of TNA)	0.895	−0.125	0.304	0.764*	2.238**	−0.248	1.082	0.252
Retail fund shares								
Active reallocation	0.001	−0.031	−0.027	0.010	0.097	0.022	0.053	−0.102
Flows (% of TNA)	0.636	0.252	0.248	0.603	1.328	1.793*	0.759	−1.725
Institutional fund shares								
Active reallocation	0.046	−0.182	−0.042	0.010	0.235	−0.103**	0.033	−0.024
Flows (% of TNA)	1.524	−0.237	0.691	1.188**	3.029**	−2.803	1.343	0.954
Additional Information								
Surprises	27	27	27	27	27	27	27	27
Observations	471	471	471	471	471	471	471	471

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

Table B.12: Benchmarking to Fratzscher et al. (2016a) using a different fund universe (impact over 4 lags)

The fund universe is fixed as of the 1st of January 2010 and the sample runs until September 2012.

The table shows the (cumulative) effect associated with the surprise change in Euro area rates. Each line in the table refers to a different regression with different dependent variables as indicated in the table (see Section 4.2 in the main text for the definition of dependent variables).

(a) Impact of a surprise change in EA short-term rates – until September 2012

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.119	−0.184	−0.113	0.172	0.261**	−0.010	−0.185	0.062
Passive reallocation *return*	−1.484*	−0.624	−0.477	−4.388**	1.666**	0.487**	3.291**	1.277**
Passive reallocation *FX*	−2.279***	0.829***	−0.103**	0.894	−1.061***	0.087**	1.546	0.509***
Total reallocation	−3.996***	0.085	−0.640	−4.023	0.995	0.536***	5.279**	1.850**
Separate estimation (equation by equation)								
Flows (% of TNA)	−1.610	−2.443	−1.868	−0.139	2.978	−1.471	−2.220	−0.240
Surprises	37	37	37	37	37	37	37	37
Observations	710	710	710	710	710	710	710	710
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
−26.3***	−38.3**	−13.6	−14.4	−17.4	6.2*	32.5***	30.7***	21.9***

(b) Impact of a surprise change in EA 10-year yields – until September 2012

	Equity				Bonds			
	WE	USAPJ	GLOB	EM	WE	USAPJ	GLOB	EM
Joint estimation with restriction on the sum of the fitted values								
Active reallocation	−0.281***	−0.263***	−0.082	0.397***	−0.004	0.015	0.108*	0.046
Passive reallocation *return*	−0.194	−0.486**	−0.155	0.183	0.159	0.069	0.247	0.076
Passive reallocation *FX*	−2.482	−0.912	−0.431	0.079	−1.610	−0.162	4.523	−0.299
Total reallocation	−3.043*	−1.705	−0.725	0.548	−1.557	0.032	5.277	−0.068
Separate estimation (equation by equation)								
Flows (% of TNA)	−2.314***	−2.513***	−0.936	1.014**	−0.456	1.018	0.325	0.341
Surprises	37	37	37	37	37	37	37	37
Observations	710	710	710	710	710	710	710	710
Benchmarks:	Equity				Bonds			
EUR/USD	WE	USA	GLOB	EM	WE	USA	GLOB	EM
0.6	−2.8	−9.7	−6.5	−0.0	1.7	1.0	0.8	−1.4

Note: For coefficients the stars indicate the p-value of an F-Test of the sum of the contemporaneous effect of the monetary policy surprise and lags 1 to 4 (* implies $p < 0.1$, ** implies $p < 0.05$, *** implies $p < 0.01$).

B.5 Fund universe of 2012 vs. fund universe of 2014

This Appendix provides a formal statistical test of the robustness of our coefficients to different sampling. We jointly estimate the coefficients from our baseline fund universe (as of January 1st, 2012) that we used in panel c) of Tables 2.5 and 2.6 and the secondary universe (as of January 1st, 2014) in Table B.9 in the Appendix of the main paper. Then we test the null hypothesis, that the estimated cumulative response to a monetary policy surprise is equal for both fund universes.

In order to test for the equality of these coefficients, we jointly estimate the same regression from two samples in a SUR setup. The subsequent test for the equality of the coefficients takes into account the covariances of the coefficients. Throughout the paper we use either Driscoll-Kray standard errors with a small sample adjustment or Newey-West standard errors. Here we use less conservative standard errors (standard errors clustered by date, no small sample adjustment but otherwise equal to Driscoll-Kraay standard errors) in order to rely on STATA routines for the SUR estimation. Generally, this makes standard errors smaller and the rejection of the H_0 **more** likely, i.e. it is harder to establish the equality of coefficients as we aim for. The new joint estimation using both universes will produce slightly different standard errors compared to those obtained in the original regressions, while point estimates are unchanged.

We report the results in Tables B.13 and B.14. The last column reports the p-value of a t-test with: $H_0 : \sum \theta_{2012} - \sum \theta_{2014} = 0$. Tables B.13 and B.14 show that all p-values are larger than 0.1 – and many coefficients are virtually identical.

Table B.13: Formal Comparison of Coefficients of the Impact of a surprise change in EA short-term rates (after September 2014): Universe of 2012 vs. Universe of 2014 (after September 2014)

This table shows differences in the estimated coefficient of interest $\sum \theta_i$ between two samples, the fund universe of 2012 and the fund universe of 2014. We jointly estimate both coefficients in a SUR setup. The last column reports the p-value of a t-test with: $H_0 : \sum \theta_{2012} - \sum \theta_{2014} = 0$.

Fund Category	$\sum \theta_{2012}$	$\sum \theta_{2014}$	$\sum - \sum$	p-value
Active reallocation				
Equity – WE	0.371	0.204	0.167	0.76
Equity – USAPJ	−0.302	−0.116	−0.186	0.65
Equity – GLOB	−0.255	−0.117	−0.138	0.63
Equity – EM	0.088	−0.304	0.392	0.36
Bond – WE	−0.080	−0.164	0.084	0.89
Bond – USAPJ	−0.103	0.186	−0.288	0.28
Bond – GLOB	−0.212	0.127	−0.339	0.51
Bond – EM	0.127	−0.010	0.137	0.72
Passive reallocation *return*				
Equity – WE	8.729***	8.023***	0.706	0.84
Equity – USAPJ	−0.151	−0.008	−0.144	0.93
Equity – GLOB	1.342	1.546	−0.204	0.88
Equity – EM	−1.181	−0.367	−0.813	0.74
Bond – WE	−2.430	−2.522	0.092	0.97
Bond – USAPJ	−0.938**	−1.417**	0.480	0.51
Bond – GLOB	−3.913**	−3.574**	−0.339	0.89
Bond – EM	−1.793***	−1.478**	−0.316	0.73
Passive reallocation *FX*				
Equity – WE	−4.123***	−2.768**	−1.355	0.48
Equity – USAPJ	2.598**	2.658***	−0.060	0.97
Equity – GLOB	−1.598	−0.723	−0.876	0.68
Equity – EM	3.044**	2.277**	0.767	0.62
Bond – WE	−2.913	−3.316	0.403	0.89
Bond – USAPJ	0.393**	−0.464	0.858	0.33
Bond – GLOB	2.054	1.784	0.269	0.92
Bond – EM	0.646	1.080**	−0.435	0.50
Total reallocation				
Equity – WE	5.795**	6.073***	−0.278	0.94
Equity – USAPJ	2.095	2.395*	−0.300	0.88
Equity – GLOB	−0.751	0.548	−1.299	0.63
Equity – EM	1.844	1.500	0.344	0.91
Bond – WE	−4.968*	−5.567**	0.600	0.87
Bond – USAPJ	−0.442	−1.509	1.067	0.35
Bond – GLOB	−2.841	−2.344	−0.497	0.88
Bond – EM	−1.304	−0.835	−0.468	0.66
Flows (% of TNA)				
Equity – WE	3.865	3.258	0.607	0.87
Equity – USAPJ	−0.915	0.812	−1.727	0.62
Equity – GLOB	−0.807	0.792	−1.599	0.48
Equity – EM	1.470	−0.904	2.374	0.49
Bond – WE	1.375	0.815	0.561	0.91
Bond – USAPJ	−2.975	5.682	−8.657	0.11
Bond – GLOB	0.212	3.235	−3.023	0.41
Bond – EM	3.691	1.251	2.440	0.63

Table B.14: Formal Comparison of Coefficients of the Impact of a surprise change in EA 10-year yields (after September 2014): Universe of 2012 vs. Universe of 2014 (after September 2014)

This table shows differences in the estimated coefficient of interest $\sum\theta_i$ between two samples, the fund universe of 2012 and the fund universe of 2014. We jointly estimate both coefficients in a SUR setup. The last column reports the p-value of a t-test with: $H_0 : \sum\theta_{2012} - \sum\theta_{2014} = 0$.

Fund Category	$\sum\theta_{2012}$	$\sum\theta_{2014}$	$\sum-\sum$	p-value
Active reallocation				
Equity – WE	−0.002	−0.080	0.077	0.56
Equity – USAPJ	−0.120	−0.033	−0.087	0.43
Equity – GLOB	−0.040	0.001	−0.041	0.65
Equity – EM	0.003	−0.003	0.006	0.95
Bond – WE	0.178	0.153	0.025	0.89
Bond – USAPJ	−0.037	−0.017	−0.021	0.80
Bond – GLOB	0.054	0.086	−0.032	0.82
Bond – EM	−0.047	−0.060	0.013	0.91
Passive reallocation *return*				
Equity – WE	3.377***	3.100***	0.277	0.80
Equity – USAPJ	−0.265	−0.141	−0.123	0.79
Equity – GLOB	0.512*	0.655**	−0.143	0.72
Equity – EM	0.156	0.372	−0.215	0.76
Bond – WE	−1.132**	−1.280***	0.147	0.82
Bond – USAPJ	−0.413***	−0.600***	0.187	0.37
Bond – GLOB	−1.679***	−1.524***	−0.154	0.82
Bond – EM	−0.687***	−0.561***	−0.125	0.63
Passive reallocation *FX*				
Equity – WE	−1.798***	−1.276***	−0.522	0.37
Equity – USAPJ	1.006***	0.938***	0.068	0.86
Equity – GLOB	0.051	0.142	−0.092	0.70
Equity – EM	1.270***	0.942***	0.328	0.55
Bond – WE	−0.987	−1.237**	0.250	0.77
Bond – USAPJ	0.170***	0.099	0.071	0.60
Bond – GLOB	−0.007	0.069	−0.076	0.85
Bond – EM	0.355***	0.296***	0.059	0.68
Total reallocation				
Equity – WE	1.500*	1.688**	−0.189	0.86
Equity – USAPJ	0.604	0.733*	−0.129	0.82
Equity – GLOB	0.520	0.796**	−0.276	0.57
Equity – EM	1.294*	1.205**	0.089	0.92
Bond – WE	−1.883***	−2.289***	0.406	0.69
Bond – USAPJ	−0.174	−0.428**	0.254	0.27
Bond – GLOB	−1.771***	−1.533***	−0.238	0.77
Bond – EM	−0.472**	−0.447**	−0.025	0.93
Flows (% of TNA)				
Equity – WE	0.895	0.167	0.729	0.45
Equity – USAPJ	−0.125	0.297	−0.422	0.66
Equity – GLOB	0.304	0.507	−0.202	0.80
Equity – EM	0.764	0.551	0.214	0.76
Bond – WE	2.238**	1.462	0.775	0.57
Bond – USAPJ	−0.248	0.696	−0.944	0.60
Bond – GLOB	1.082	1.188*	−0.106	0.92
Bond – EM	0.252	−0.135	0.387	0.79

Appendix C

Appendix to Chapter 3

C.1 Solution of the Election Hegemon Problem

We can solve the first of the FOCs for c and plug into the second FOC:

$$p^* = \frac{\sqrt{b}\,(\pi\Gamma - \Lambda) + \frac{\Gamma^2\pi^2}{2}\left(\sqrt{b} - 1\right)}{\frac{\pi^2\Gamma^2}{2} - 2}$$

And for c^* we get:

$$c^* = \frac{\pi\Gamma}{2}\left(p^* - \sqrt{b} + 1\right) = \frac{\pi\Gamma}{2}\left(\frac{\sqrt{b}\,(\pi\Gamma - \Lambda) + \frac{\Gamma^2\pi^2}{2}\left(\sqrt{b} - 1\right)}{\frac{\pi^2\Gamma^2}{2} - 2} - \sqrt{b} + 1\right)$$

From our FOCs it also follows that the Hessian is:

$$H = \begin{pmatrix} -2 & \pi\Gamma \\ \pi\Gamma & -2 \end{pmatrix}$$

The second order sufficient condition for a critical point to be a maximum is that the Hessian be negative definite at the critical point. Therefore, we need the principal minors $|H_{11}| = -2 < 0$ and

$$\begin{vmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{vmatrix} = 4 - \pi^2\Gamma^2 > 0.$$

This holds if $|\pi\Gamma| < 2$.

C.2 Formal Solution of the Constrained Optimization Problem

$$\begin{array}{ll} \max_{c,p} & \pi\Gamma\left(\chi + (1 - \sqrt{b} + p)c + b - \sqrt{b}p\right) - \Lambda\left(b - \sqrt{b}p\right) - c^2 - p^2 \\ & s.t. \quad c^2 + p^2 \leq y \end{array}$$

We have:

$$\mathcal{L}_\lambda(c,p) = \pi\Gamma\left(\chi + (1-\sqrt{b}+p)c + b - \sqrt{b}p\right) - \Lambda\left(b - \sqrt{b}p\right) - c^2 - p^2 - \lambda(c^2+p^2-y)$$

This yields the following first order necessary conditions for a maximum:

$$\begin{aligned}
\frac{\partial \cdot}{\partial c} &= \pi\Gamma\left(1-\sqrt{b}+p\right) - 2c - 2\lambda c && \overset{!}{=} 0\\
\frac{\partial \cdot}{\partial p} &= \pi\Gamma\left(c-\sqrt{b}\right) + \Lambda\sqrt{b} - 2p - 2\lambda p && \overset{!}{=} 0\\
& c^2+p^2-y && \leq 0\\
& \lambda && \geq 0\\
& \lambda(c^2+p^2-y) && \overset{!}{=} 0
\end{aligned}$$

If $\lambda = 0$ then the problem is the same as in the unconstrained optimization problem. If $\lambda \geq 0$ then we can use the binding budget constraint to solve for c:

$$c = \pm\sqrt{y-p^2}$$

And from the first two FOCs we get:

$$\frac{\pi\Gamma}{2c}\left(1-\sqrt{b}+p\right) - 1 = \lambda$$

and

$$\frac{\pi\Gamma}{2p}\left(c-\sqrt{b}\right) + \frac{\Lambda\sqrt{b}}{2p} - 1 = \lambda.$$

Setting these equal leads to

$$p\left(1-\sqrt{b}+p\right) = c\left(c-\sqrt{b}\right) + c\frac{\Lambda\sqrt{b}}{\pi\Gamma}.$$

We plug in the two possible solutions for c (i.e. $\pm\sqrt{}$) we obtained from the binding budget constraint and solve both

$$p_+^*\left(1-\sqrt{b}+p_+^*\right) = \sqrt{y-{p_+^*}^2}\left(\sqrt{y-{p_+^*}^2} - \sqrt{b} + \frac{\Lambda\sqrt{b}}{\pi\Gamma}\right)$$

for p_+^* such that $c_+^* = \sqrt{y-{p_+^*}^2}$ and $\lambda_+^* = \frac{\pi\Gamma}{2c_+^*}\left(1-\sqrt{b}+p_+^*\right) - 1$ and

$$p_-^*\left(1-\sqrt{b}+p_-^*\right) = -\sqrt{y-{p_-^*}^2}\left(-\sqrt{y-{p_-^*}^2} - \sqrt{b} + \frac{\Lambda\sqrt{b}}{\pi\Gamma}\right)$$

for p_-^* such that $c_-^* = -\sqrt{y-{p_-^*}^2}$ and $\lambda_-^* = \frac{\pi\Gamma}{2c_-^*}\left(1-\sqrt{b}+p_-^*\right) - 1$. The utility maximum for a binding budget constraint is at the solution to these FOCs for which $\lambda \geq 0$ holds unless the solution is a corner solution. We omit the second order constraints we could derive from a bordered Hessian here. If there is a solution with $\lambda = 0$ and $c^{*2} + p^{*2} \leq y$, this solution points to the optimal composition of spending.

C.3 Formal Solution of the Election War Case

There are two ways to approach this problem in general: One is to solve a system of 4 linear equations in 4 variables, namely c_+, c_-, p_+, p_-.

$$
\begin{aligned}
\frac{\partial \cdot}{\partial c_+} &= \pi\Gamma_+\left(p_- + p_+ - \sqrt{b} + 1\right) - 2c_+ && \overset{!}{=} 0\\
\frac{\partial \cdot}{\partial p_+} &= \Lambda_+\sqrt{b} - 2p_+ + \pi\Gamma_+\left(c_- + c_+ - \sqrt{b}\right) && \overset{!}{=} 0\\
\frac{\partial \cdot}{\partial c_-} &= -\pi\Gamma_-\left(p_- + p_+ - \sqrt{b} + 1\right) - 2c_- && \overset{!}{=} 0\\
\frac{\partial \cdot}{\partial p_-} &= \Lambda_-\sqrt{b} - 2p_- - \pi\Gamma_-\left(c_- + c_+ - \sqrt{b}\right) && \overset{!}{=} 0
\end{aligned}
$$

This is equivalent to the more intuitive way of plugging in the best response of the "$-$"-power into the FOCs of the "+"-power and thereby deriving a best response of the one power to the best response of the other power. The necessary steps will be shown in the following:

First we derive the best responses of the "$-$"-player

$$
\begin{aligned}
c_-^*(c_+, p_+) &= \frac{\pi\,\Gamma_-\,\left(2\,p_+ + \Lambda_-\,\sqrt{b} - 2\,\sqrt{b} - \Gamma_-\,c_+\,\pi + \Gamma_-\,\sqrt{b}\,\pi + 2\right)}{\pi^2\Gamma_-^2 - 4}\\
p_-^*(c_+, p_+) &= -\frac{2\,\Lambda_-\,\sqrt{b} + \Gamma_-^2\,\pi^2 + \Gamma_-^2\,\pi^2\,p_+ - 2\,\Gamma_-\,c_+\,\pi - \Gamma_-{}^2\,\sqrt{b}\,\pi^2 + 2\,\Gamma_-\,\sqrt{b}\,\pi}{\Gamma_-^2\,\pi^2 - 4}
\end{aligned}
$$

Subsequently we plug in:

$$
\begin{aligned}
\frac{\partial \cdot}{\partial c_+} &= \pi\Gamma_+\left(-\frac{2\,\Lambda_-\,\sqrt{b} + \Gamma_-^2\,\pi^2 + \Gamma_-^2\,\pi^2\,p_+ - 2\,\Gamma_-\,c_+\,\pi - \Gamma_-{}^2\,\sqrt{b}\,\pi^2 + 2\,\Gamma_-\,\sqrt{b}\,\pi}{\Gamma_-^2\,\pi^2 - 4} + p_+ - \sqrt{b} + 1\right) - 2c_+ && \overset{!}{=} 0\\
\frac{\partial \cdot}{\partial p_+} &= \Lambda_+\sqrt{b} - 2p_+ + \pi\Gamma_+\left(\frac{\pi\,\Gamma_-\,\left(2\,p_+ + \Lambda_-\,\sqrt{b} - 2\,\sqrt{b} - \Gamma_-\,c_+\,\pi + \Gamma_-\,\sqrt{b}\,\pi + 2\right)}{\pi^2\Gamma_-^2 - 4} + c_+ - \sqrt{b}\right) && \overset{!}{=} 0
\end{aligned}
$$

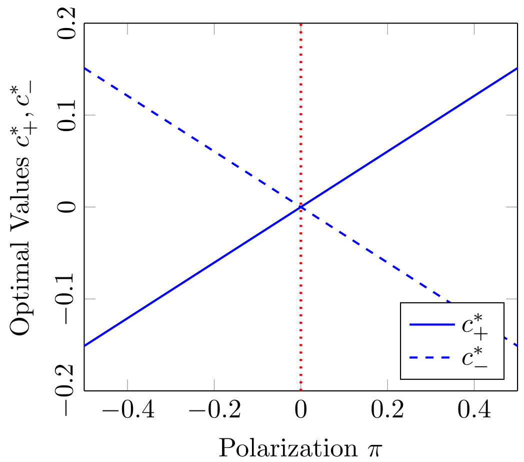
Both solution methods lead to:

$$
\begin{aligned}
c_+^* &= -\frac{2\pi\Gamma_+ - \Gamma_+{}^2\pi^2\sqrt{b} - 2\pi\Gamma_+\sqrt{b} + \pi\Gamma_+\Lambda_+\sqrt{b} + \pi\Gamma_+\Lambda_-\sqrt{b} + \Gamma_+\Gamma_-\pi^2\sqrt{b}}{\pi^2\Gamma_+{}^2 - \pi^2\Gamma_+\Gamma_-2 + \pi^2\Gamma_-{}^2 - 4}\\
p_+^* &= -\frac{\left(4\Lambda_+\sqrt{b} + 2\Gamma_+{}^2\pi^2 - 2\Gamma_+{}^2\pi^2\sqrt{b} - 2\Gamma_+\Gamma_-\pi^2 - 4\pi\Gamma_+\sqrt{b} + 2\Gamma_+\Gamma_-\pi^2\sqrt{b} + \Gamma_+{}^2\Lambda_-\pi^2\sqrt{b} - \Gamma_-{}^2\Lambda_+\pi^2\sqrt{b} + \Gamma_+\Gamma_-\Lambda_+\pi^2\sqrt{b} - \Gamma_+\Gamma_-\Lambda_-\pi^2\sqrt{b}\right)}{2\left(\pi^2\Gamma_+{}^2 - \pi^2\Gamma_+\Gamma_-2 + \pi^2\Gamma_-{}^2 - 4\right)}\\
c_-^* &= \frac{2\pi\Gamma_- + \Gamma_-{}^2\pi^2\sqrt{b} - 2\pi\Gamma_-\sqrt{b} + \pi\Gamma_-\Lambda_+\sqrt{b} + \pi\Gamma_-\Lambda_-\sqrt{b} - \Gamma_+\Gamma_-\pi^2\sqrt{b}}{\pi^2\Gamma_+{}^2 - \pi^2\Gamma_+\Gamma_-2 + \pi^2\Gamma_-{}^2 - 4}\\
p_-^* &= -\frac{\left(4\Lambda_-\sqrt{b} + 2\Gamma_-{}^2\pi^2 - 2\Gamma_-{}^2\pi^2\sqrt{b} - 2\Gamma_+\Gamma_-\pi^2 + 4\pi\Gamma_-\sqrt{b} + 2\Gamma_+\Gamma_-\pi^2\sqrt{b} - \Gamma_+{}^2\Lambda_-\pi^2\sqrt{b} + \Gamma_-{}^2\Lambda_+\pi^2\sqrt{b} - \Gamma_+\Gamma_-\Lambda_+\pi^2\sqrt{b} + \Gamma_+\Gamma_-\Lambda_-\pi^2\sqrt{b}\right)}{2\left(\pi^2\Gamma_+{}^2 - \pi^2\Gamma_+\Gamma_-2 + \pi^2\Gamma_-{}^2 - 4\right)}
\end{aligned}
$$

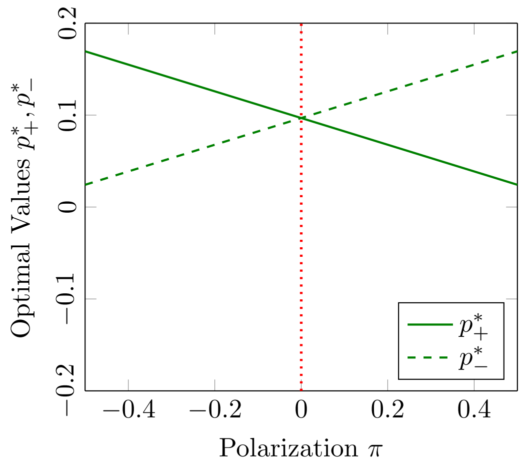
C.4 The Liberal Symmetric Election War

The Liberal Symmetric Election War adds another power with opposite political preferences that cares equally about liberalism and assigns the same geo-political importance to the target country.[1]

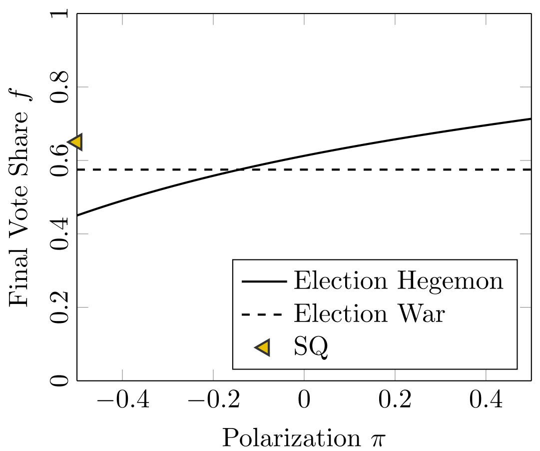
Figure C.1: Equilibrium Choices and Outcomes in Liberal Symmetric Election War



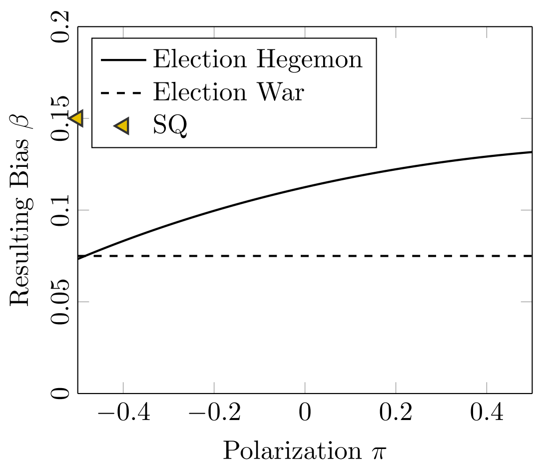
(a) Equilibrium c*



(b) Equilibrium p*



(c) Incumbent Vote Share Comparison



(d) Bias Comparison

C.5 Alternative Cost Functions

In order to shed light on the limits of our theoretical specification, we perform a quick thought experiment. A possible specification that would lead to zero investment in processes

[1] We use $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$, $\Gamma_- = 0.75$, $\Lambda_- = 0.5$ and the rest of the parameters as in the election hegemon scenario.

($p^* = 0$) and $c^* \geq 0$ could look like this:

$$u' = \pi\Gamma\left(\chi + \rho c + (b - \sqrt{b}p)\right) - |c| - |p|$$

In the following we look at the case $\pi = \Gamma = 1$: Since $\sqrt{b} < 1$, it would never pay off to reduce the bias in this specification. If $\rho = 1$ (or even, $\rho > 1$), then one would like to invest $c^* \in [0, \infty)$, i.e. the maximum amount possible in spending towards a candidate – realistically until one hits the budget constraint – allowing for all values c such that the election result fulfills: $f(c, p) = \chi + c \in [0, 1]$. By including an additional term '$-\Lambda\sqrt{b}p$' in the above utility function one could achieve investment $p < 0$ (while $c = 0$) for sufficiently high values of Λ. In the case of $\rho = (1 + \Lambda)\sqrt{b} = 1$ one could use an arbitrary mix of $p < 0$ and $c > 0$ as long as $\chi + \rho c + (b - \sqrt{b}p) \in [0, 1]$. Any kind of comparative statics in these kind of models would provide us with limited insights away from certain thresholds. We think that the core assumptions of the decision-theoretic foundation of our model are reasonably justified.

Our preferred way to think about cases with $c = 0$ (or alternatively $p = 0$), within the framework of our model is the following: one could artificially increase the cost of the first unit invested into candidates c, for example by using a cost function like

$$u'' = \pi\Gamma\left(\chi + c + \left(\sqrt{b} - p\right)\left(\sqrt{b} - c\right)\right) - \Lambda\left(b - \sqrt{b}p\right) \underbrace{-(c^2 + \tau_c \cdot \mathbf{1}_{c\neq 0}) - p^2}_{\text{alternative cost function}}.$$

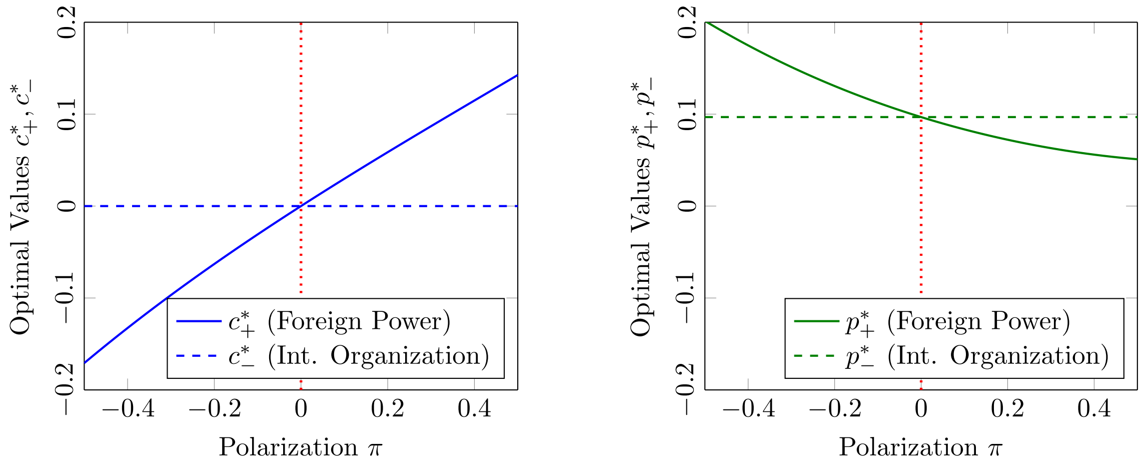
Depending on $\tau_c > 0$ this could lead to $c = 0$ and $p \neq 0$ for low levels of overall investment. Think of this as an entry cost one has to pay in order to get access to a certain political force. For low levels of entry cost or very high levels of overall expenditure one would again get quite similar results compared to our baseline scenario.

In our point of view, the most promising areas for future development of our theory would lie in extensions that allow for explicit modelling of voter behavior, or take into account the informational content of actions by a foreign power, rather than in a generalization of the predictions of our simple decision-theoretic model to more general functional forms.

C.6 The Effect of (Democratic) International Organizations

Pevehouse (2002a) and Pevehouse (2002b) argue that international organizations, dominated by democracies, have different ways of cajoling elites into committing to reforms and sticking with them. Unlike states, which feel compelled to prioritize geo-political agendas over democracy promotion (Reiter, 2001), international organizations delegate the enforcement of democratic norms to specialized bureaucracies. If we add an outside actor that only cares about liberalism to our baseline scenario, we can easily incorporate international organizations into our model. Since the policy outcome does not matter to the international organization, it will spend a constant amount p on bias reduction regardless of political divisions.[2]

Figure C.2: Equilibrium Choices with International Organization

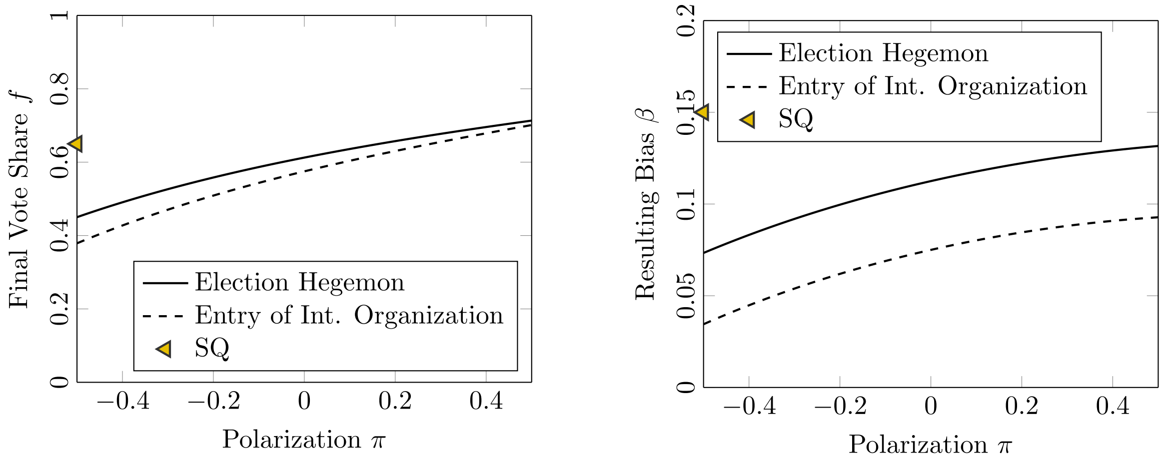


(a) Equilibrium c* – Liberal Power

(b) Equilibrium p* – Liberal Power

Predictions The result is a reduction in the bias of the election compared to the scenario of an election hegemon, and higher expenditure for the intervening power, especially in highly polarized contests.

Figure C.3: Outcomes with International Organization



(a) Incumbent Vote Share Comparison

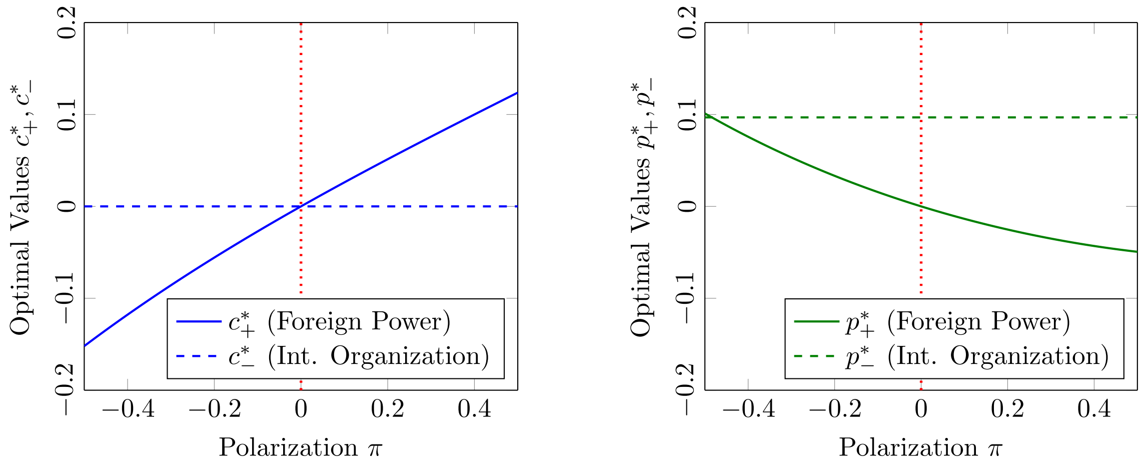
(b) Bias Comparison

[2]In Figures C.2, C.3 we use $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$ for the foreign power and $\Gamma_- = 0$, $\Lambda_- = 0.5$ for the international organization.

Facing an illiberal power, spending by the international organization on process interventions p might sometimes counteract the investment by the foreign power.[3]

Compared to the the illiberal election hegemon the bias will decrease. It is worthwhile to note, that in our simple linear specification the spending of the international organization is not influenced by the amount that the international power spends on p. This means there is no crowding-out effect of spending by the international organization on the spending of the international power.[4]

Figure C.4: Equilibrium Choices with International Organization



(a) Equilibrium c* – Aliberal Power **(b)** Equilibrium p* – Aliberal Power

Figure C.5: Expenditure on p with International Organization

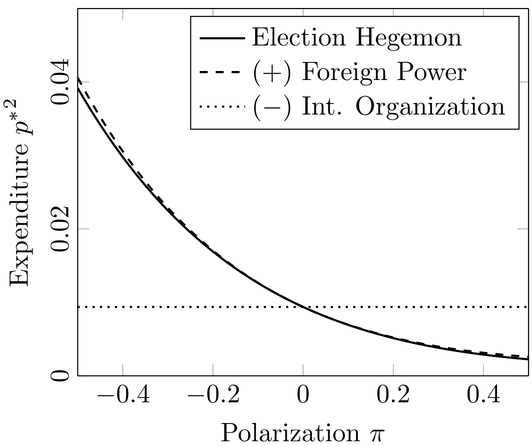


Figure C.5 demonstrates that democratic international organizations consistently reduce

[3]In Figures C.4a and C.4b we use $\Gamma_+ = 0.75$, $\Lambda_+ = 0$ for the foreign power and $\Gamma_- = 0$, $\Lambda_- = 0.5$ for the international organization.

[4]Another interesting consequence in terms of outcomes is the following: the case of an illiberal power with $\Gamma_+ = 0.75$ and $\Lambda = 0$ and the international organization with $\Gamma_- = 0$ and $\Lambda = 0.5$, in terms of bias and vote share, is just the same as the case of an election hegemon with $\Gamma = 0.75$ and $\Lambda = 0.5$.

bias in elections, without crowding out pro-democracy investments by the liberal hegemon. Thus, such organizations are good for democracy.

C.7 Regime Overthrow

One might think of the option to decide – ex-ante – whether to influence a democratic regime via contributions towards candidates and processes or whether it seems more attractive to attempt to overthrow the regime.

An easy specification for the resulting utility in these cases would be to allow overthrowing at a fixed cost r while there is an additional cost Λ for those international powers that care about democracy:

$$u_{int} = \Gamma A_{gov} - \Lambda - r$$

In this case, the regime is overthrown in order to give the government party the full discretion over the choice of policies. If one installs the opposition in power after the revolt, the utility would be.

$$u_{int} = \Gamma B_{opp} - \Lambda - r$$

The model can be easily adapted to work with an (endogenous) probability of success. This would change the payoffs in expected terms, since one would have to take into account the outcome of an election hegemon scenario or the election war that would ensue following a failed attempt to overthrow. It would make overthrow less likely to occur. One could even make the probability of success contingent on some exerted effort.

Formally incorporating a probability of success $q \in (0,1]$ in the election war scenario would lead to:

$$u = q\Gamma A_{gov} + (1-q)u_{int}\left(c_+^*, c_-^*, p_+^*, p_-^*\right) - \Lambda - r$$

Then overthrow happens if:

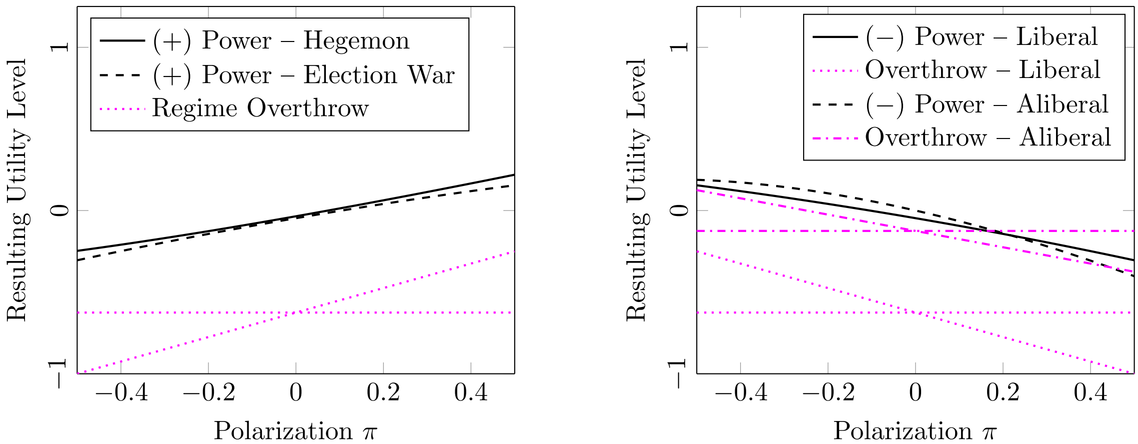
$$\begin{aligned} q\Gamma A_{gov} + (1-q)\cdot u_{int}\left(c_+^*, c_-^*, p_+^*, p_-^*\right) - \Lambda - r &> u_{int}\left(c_+^*, c_-^*, p_+^*, p_-^*\right) \\ \Gamma A_{gov} - \frac{\Lambda + r}{q} &> u_{int}\left(c_+^*, c_-^*, p_+^*, p_-^*\right) \end{aligned}$$

It can be seen that introducing a probability of success will only change the cost structure of the problem – the cost component that depends on liberal concerns will increase to $\frac{\Lambda}{q}$ and the expenditure component to $\frac{r}{q}$. In the following we assume $q = 1$.

To simplify matters, we will assume that any attempt of regime overthrow will succeed and the policy that can be implemented in this case is either A_{gov} or B_{opp}. Furthermore we assume that only one power gets drawn to have an opportunity to overthrow. This avoids something akin to a regime overthrow contest in the election war scenario.

Predictions From Figure C.6a we see that an international power that cares about democracy and election outcomes as specified by the parameters $\Gamma = 0.75$ and $\Lambda = 0.5$ will not overthrow the regime in most cases[5] since the utility of overthrowing is strictly below both the hegemon and the symmetric election war case. However, under certain circumstances – one could think of a liberal power with relatively low commitment to liberal values facing another power with considerably higher stakes – even a liberal power might decide to overthrow.

Figure C.6: Utility of Regime Overthrow vs. Baseline Scenarios



(a) Liberal Election Hegemon and Liberal Symmetric Election War

(b) Liberal Symmetric and Aliberal Asymmetric Election War

In the symmetric election war the foreign power with opposite political preferences compared to Figure C.6a also prefers the election war over the regime overthrow.[6] In an asymmetric election war, however, if the target is sufficiently polarized and the power does not care about democracy per se, regime overthrow might sometimes happen. From Figure C.6b, we see that the utility of the aliberal power falls below -0.125 for large π, this means for $B_{opp} = 0$ and values close to $A_{gov} = 0.5$ it will prefer to overthrow the regime and install the opposition in power in order to obtain utility -0.125, and for values of π close to -0.5 it will overthrow in favor of the government.[7] Again, here we stick to the parametrization

[5]Let us assume for now that $B_{opp} = 0$ and $A_{gov} \in [-0.5, 0.5]$, $r = 0.125$ and we take the rest of the parameters from our previous analyses. Overthrowing the democratic regime in favor of the opposition would give us utility $u_{int} = 0.75 \cdot 0 - 0.5 - 0.125 = -0.625$ while overthrowing in favor of the government would give an utility of $u_{int} = 0.75 \cdot A_{gov} - 0.5 - 0.125$, i.e. between -1 for $A_{gov} = -0.5$ and -0.25 for $A_{gov} = 0.5$.

[6]For the $(-)$ power with $\Gamma = -0.75$ and $\Lambda = 0.5$ in the symmetric election war overthrowing in favor of the opposition gives $u_{int} = -0.75 \cdot 0 - 0.5 - 0.125 = -0.625$ while overthrowing in favor of the government would give an utility of $u_{int} = -0.75 \cdot A_{gov} - 0.5 - 0.125$, i.e. between -0.25 for $A_{gov} = -0.5$ and -1 for $A_{gov} = 0.5$.

[7]For the $(-)$ power with $\Gamma = -0.5$ and $\Lambda = 0$ in the asymmetric election war, however, overthrowing in favor of the opposition gives $u_{int} = -0.5 \cdot 0 - 0 - 0.125 = -0.125$ while overthrowing in favor of the government would give an utility of $u_{int} = -0.5 \cdot A_{gov} - 0 - 0.125$, i.e. between 0.125 for $A_{gov} = -0.5$ and -0.375 for $A_{gov} = 0.5$.

of our examples from the main body. Changing some parameters in a way that creates a higher degree of asymmetry can make overthrow even more likely.

C.8 Endogenous Choice of Policy Positions

This section of the Appendix provides a simple extension of our baseline model to allow for candidates choosing their platforms endogenously. We add a first stage in which both the government and the opposition simultaneously determine their platforms. The candidates take into account both the reaction of the foreign powers to their choice of platform and the change in behavior by the other party. The coefficients γ_{gov} and γ_{opp} determine how much a candidate cares about deviations of her platform from her ideal point. This is a very simplified version of an exercise similar to Grossman and Helpman (1996) – the main difference is the timing. In our setting parties are the first to determine their platforms.

We formulate the preferences of the government as:

$$u_{gov} = f(A_{gov}, B_{opp}) - \gamma_{gov}(\overline{A}_{gov} - A_{gov})^2,$$

where $\overline{A}_{gov}$ refers to the ideal point of the government and A_{gov} to its chosen platform. The function $f(A_{gov}, B_{opp})$ maps from platforms to final voteshares according to the equilibrium behavior of the international powers described in Section Predictions. In the same manner we define:

$$u_{opp} = (1 - f(A_{gov}, B_{opp})) - \gamma_{opp}(\overline{B}_{opp} - B_{opp})^2,$$

where $\overline{B}_{opp}$ denotes the ideal point of the opposition.

We assume that the chosen platform will affect the support decisions of the foreign power but in this simple extension we do not explicitly model how domestic voters might be affected by a change in policy positions. This could be justified if candidates adapt their policies in issues that are highly relevant for outside actors but less salient to the electorate. Candidates maximize the sum of their vote shares and a term that penalizes deviations of the chosen policy platform from the ideal point of the candidate.

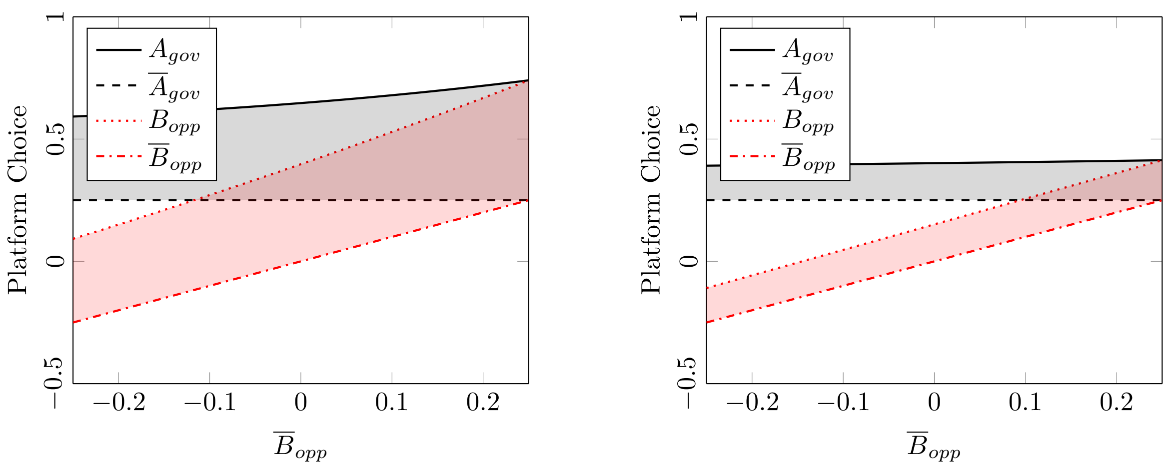
Predictions For the case of $\gamma_{gov} = \gamma_{opp}$ the FOCs of the candidates determine a unique solution to the platform choice problem. There is a unique Nash equilibrium in which both parties move their positions closer to the election hegemon (or the "stronger" power in the election war scenario). Each candidate moving her platform by the same amount.

The most important takeaway from the case $\gamma_{gov} = \gamma_{opp}$ is the following: resulting ex-post polarization $\pi = A_{gov} - B_{opp}$ after the platform-setting game of the candidates equals ex-ante polarization $\overline{\pi} = \overline{A}_{gov} = \overline{B}_{opp}$ (i.e. the level of polarization that would prevail without the presence of a foreign intervener) in both the hegemon and the election war scenario. In

Figure C.7 this can be seen best at $\overline{A}_{gov} = \overline{B}_{opp} = 0.25$, when both parties choose the same platform.

In the election war scenario political platforms have a smaller effect on the election result since changing the results of an election becomes more costly and, therefore, the payoff of trying to appeal to the foreign power is lower. This becomes apparent in the extent to which candidates adapt their platforms.[8] For the case of $\gamma_{gov} \neq \gamma_{opp}$ the FOCs of the parties no longer point to a unique solution.

Figure C.7: Candidates Care Equally about Their Platforms



(a) Election Hegemon

(b) Election War

C.9 Raw Data

Table C.1: Sample Pilot Study

Country	*Year*	*Election_id*	*Polarization*	*War_usa*	*Power*
Bahrain	2002	692-2002-1024-L1	1	0	
Bhutan	2008	760-2008-0324-L1	0	0	
Bosnia-Herzegovina	2000	346-2000-1111-L1	-1	0	
Bosnia-Herzegovina	2002	346-2002-1005-L1	-1	0	
Bosnia-Herzegovina	2002	346-2002-1005-P1	-1	0	
Bosnia-Herzegovina	2006	346-2006-1001-L1	-1	0	
Bosnia-Herzegovina	2006	346-2006-1001-P1	-1	0	
Bosnia-Herzegovina	2010	346-2010-1003-P1	-1	0	
Bosnia-Herzegovina	2010	346-2010-1003-L1	-1	0	
Bulgaria	1945	355-1945-1118-L1	-1	0	

Continued on next page

[8] In the left panel of Figure C.7 we use the parameters of the liberal election hegemon with $\Gamma = 0.75$ and $\Lambda = 0.5$ and $\overline{A}_{gov} = 0.25$, where $\gamma_{gov} = \gamma_{opp} = 0.25$. In the right panel we use $\Gamma_+ = 0.75$, $\Lambda_+ = 0.5$, $\Gamma_- = 0.5$, $\Lambda_- = 0$ with the same parameters for candidates as in the left panel.

Table C.1 – continued from previous page

Country	*Year*	*Election_id*	*Polarization*	*War_usa*	*Power*
Bulgaria	1997	355-1997-0419-L1	0	0	
Burundi	1965	516-1965-0510-L1	0	0	
Burundi	2010	516-2010-0723-L1	0	0	
Cameroon	1964	471-1964-0426-L1	0	0	
Cape Verde	2011	402-2011-0206-L1	0	0	
Czechoslovakia	1946	315-1946-0526-L1	1	0	
Czechoslovakia	1990	315-1990-0608-L1	1	1	USSR/Russia
Democratic Republic of Congo	2006	490-2006-0730-L1	1	1	China
Democratic Republic of Congo	2006	490-2006-0730-P1	1	1	China
Democratic Republic of Congo	2006	490-2006-0730-P2	1	1	China
East Germany	1990	265-1990-0318-L1	1	0	
Gabon	2006	481-2006-1217-L1	0	0	
Guatemala	2003	090-2003-1109-P1	0	0	
Guatemala	2003	090-2003-1109-L1	0	0	
Guatemala	2007	090-2007-0909-P1	0	0	
Guatemala	2007	090-2007-0909-L1	0	0	
Kenya	1966	501-1966-0611-L1	1	1	USSR/Russia
Kenya	1997	501-1997-1229-L1	-1	1	China
Kenya	1997	501-1997-1229-P1	-1	1	China
Libya	1952	620-1952-0219-L1	1	1	USSR/Russia
Libya	2012	620-2012-0707-A1	0	0	
Morocco	2002	600-2002-0927-L1	0	0	
Morocco	2007	600-2007-0907-L1	1	0	
Myanmar (Burma)	1956	775-1956-0427-L1	1	1	China
Myanmar (Burma)	2010	775-2010-1107-L1	-1	1	China
Norway	1961	385-1961-0911-L1	0	1	USSR/Russia
Norway	2001	385-2001-0910-L1	0	0	
Poland	1947	290-1947-0119-L1	0	1	USSR/Russia
Poland	2011	290-2011-1009-L1	0	1	Russia
Solomon Islands	2010	940-2010-0804-L1	0	0	
Taiwan	1986	713-1986-1206-L1	-1	1	China
Taiwan	2001	713-2001-1201-L1	0	1	China
Thailand	2000	800-2000-0304-L1	0	0	
Thailand	2001	800-2001-0106-L1	0	0	
Thailand	2005	800-2005-0206-L1	0	0	
Thailand	2006	800-2006-0402-L1	0	0	
Thailand	2007	800-2007-1223-L1	0	0	
Thailand	2008	800-2008-0302-L1	0	0	
Ukraine	1991	369-1991-1201-P1	-1	1	USSR/Russia
Ukraine	1994	369-1994-0327-L1	1	1	Russia
Ukraine	1998	369-1998-0329-L1	1	1	Russia
Ukraine	1999	369-1999-1031-P1	1	1	Russia
Ukraine	2002	369-2002-0331-L1	-1	1	Russia

Continued on next page

Table C.1 – continued from previous page

Country	*Year*	*Election_id*	*Polarization*	*War_usa*	*Power*
Ukraine	2004	369-2004-1031-P1	-1	1	Russia
Ukraine	2006	369-2006-0326-L1	1	1	Russia
Ukraine	2007	369-2007-0930-L1	1	1	Russia
Ukraine	2010	369-2010-0117-P1	0	1	Russia
Ukraine	2012	369-2012-1028-L1	-1	1	Russia
Uzbekistan	1991	704-1991-1229-P1	0	0	
Zambia	1968	551-1968-1219-L1	0	1	China
Zambia	1968	551-1968-1219-P1	0	1	China
Zambia	1996	551-1996-1118-P1	1	0	
Zambia	1996	551-1996-1118-L1	1	0	

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Eidesstattliche Erklärung

Hiermit erkläre ich, die vorliegende Dissertation selbstständig angefertigt und mich keiner anderen als der in ihr angegebenen Hilfsmittel bedient zu haben. Insbesondere sind sämtliche Zitate aus anderen Quellen als solche gekennzeichnet und mit Quellenangaben versehen.

Mannheim, October 28, 2018: ______________________________

Johannes Bubeck