# Externalities as Arbitrage

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# Introduction

- Recently: persistent arbitrages with very short horizons
  - CIP: Du et al. [2018], FF-IOER Bech and Klee [2011]
  - Caused by regulation (Duffie and Krishnamurthy [2016], Bräuning and Puria [2017])
- Questions:
  - If regulation creates arbitrage, does that mean something has gone wrong?
  - What kinds of arbitrage should we observe if regulation is optimal?
  - More generally, how can we determine if macro-prudential policies are optimal?
- My answers:
  - No, optimal regulations *should* create arbitrage
  - The direction of arbitrage for an asset should depend on the covariance between the asset's payoff and the externalities being addressed
  - We can study arbitrages and recover the externalities that would rationalize them

# The Main Idea (1)

- Suppose assets $a$ and $a'$ have identical payoffs, different prices
  - and $a$ is traded by households and intermediaries (e.g. cash asset)
  - while $a'$ is int.-only (e.g. derivative)
  - examples: CIP, bond-cds basis, etc...
- An apparent arbitrage (LoOP violation) exists
- Intermediaries would like to do this arbitrage
  - we infer: a constraint prevents them from doing so
  - suppose constraint is regulatory (e.g. leverage ratio)

# The Main Idea (2)

- Now suppose household wants to buy $a$ from intermediary
- If price of $a$ higher than $a'$ ($Q_a > Q_{a'}$), intermediary thinks about hedging
  - sell $a$ to household, buy $a'$ from another int., profit
  - but this will cause constraint to tighten (e.g. use balance sheet)
- We infer: regulatory constraint prevents int. from selling $a$ to household
  - keeps risk of $a$ in intermediary-sector instead of household sector
  - macro-prudential perspective: is this a good idea?

# Results and Speculation

- Concretely: CIP violations [Du et al., 2018]
  - leverage constraints interact with customer demand to create CIP violations
  - sign of customer demand = carry trade direction
  - carry trade is risky (positive exp. returns, bad returns in stress scenario)
  - therefore, leverage constraints keep risk inside banking sector
  - inconsistent with wanting higher bank wealth in stress scenario/bad times
- Policy:
  - right now, fed checks leverage ratio in stress scenario
  - suggestion: check asset return in stress scenario instead
  - avoids penalizing hedging trades (e.g. long JPY/short USD) that use balance sheet

# This Paper

- Outline MB = MC argument
- Show assumption and "externalities as arbitrage" result
- Example based on Fanelli and Straub [2019]
- Conduct revealed preference exercise: if policy creating arbitrages is optimal, what are the externalities? Do they make sense?
  1. Gather data on arbitrages (CIP, FF-IOER) and variance-covariance matrix
  2. Construct "externality-mimicking portfolio" (EMP)
  3. Test expected returns and stress scenario returns of EMP
- Conclusion: recovered externalities do not make sense
  - CIP violations have the wrong sign

# Externalities as Arbitrage

- Optimal regulations equates marginal benefits and marginal costs
- Marginal benefits: address externalities by re-allocating consumption
  - between agents, across states and time
- Marginal costs: distorting risk-sharing and intertemporal trade
- Assumption: policy implemented via quantity regulation on financial intermediaries
- Result: risk-sharing distortions manifest as arbitrage
- Implication: externalities as arbitrage under optimal policies

# Model Outline

- Two types of agents:
  - Intermediaries (banks) $i \in \mathcal{I}$, can trade all assets
  - heterogenous households $h \in \mathcal{H}$,
    - can trade some assets, only via intermediaries (as in Gromb and Vayanos [2002])
    - planner can implement any allocation via regulations on ints.
- State $s_0$ at date zero, set $S_1$ in date one
  - $S = S_1 \cup \{s_0\}$
- Set of goods $J_s$ in state $s \in S$, prices $P_{j,s}$, socially optimal prices $P^*_{j,s}$
- Assets $a \in A$, with payoff $Z^*_{a,s} = Z_{a,s}(\{P^*_{j,s}\}_{j \in J_s})$
  - $Q_a$: price for asset

# Wedges

- Let $P^*_{j,s} + \mu_{j,s}$ be the social value of a good in money units
  - $\mu_{j,s}$ is the multiplier in planner's problem on market clearing
- When welfare theorems hold: $P^*_{j,s}$ proportional to $P^*_{j,s} + \mu_{j,s}$
- When welfare theorems fail: $P^*_{j,s}$ not proportional to $P^*_{j,s} + \mu_{j,s}$
  - e.g. incomplete markets, prices in constraints, nominal rigidities
- "Wedges" $\tau^r_{j,s}$ measure welfare theorem failure:

$$\pi^r_s \tau^r_{j,s} = -\frac{P^*_{j,s} + \mu_{j,s}}{P^*_{j,s}} + \frac{1}{|J_s|} \sum_{j' \in J_s} \frac{P^*_{j',s} + \mu_{j',s}}{P^*_{j',s}}$$

  - $\pi^r_s$: reference probability measure
  - $\tau^r_{j,s}$: ratio of social cost to price for $j$ in state $s$, vs. avg of all goods in $s$
  - $\tau^r_{j,s} > 0$: price high relative to social cost

# Externalities

- $X^h_{I,j,s}$: $h$'s income effect for $j$ in state $s$ under optimal policies
- Add up "wedges" $\tau^r_{j,s}$ weighted by income effects:

$$\Delta^{h,i,r}_s = \sum_{j \in J_s} P^*_{j,s} \tau^r_{j,s} (X^h_{I,j,s} - X^i_{I,j,s})$$

- I will call $\Delta^{h,i,r}_s$ the "externalities"
  - Benefit to planner of moving income from $i$ to $h$ in $s$
  - Sign: positive (negative) when moving income from $i$ to $h$ is good (bad)
- Planner trades off addressing these externalities with risk-sharing distortions
  - tradeoff follows from planner's FOC, ability to do transfers in $s_0$
  - transfers in $s_0$ ensure planners goal is "macro-pru" not redistribution

# MC=MB

- $M_s^{h,r}$: $h$'s SDF under optimal policies, reference measure $\pi_s^r$
  - ratio of marginal utility of income in $s$ vs. $s_0$
- MB (addressing externalities) equals MC (distorting risk-sharing):

$$\underbrace{\sum_{s \in S_1} \pi_s^r \Delta_s^{h,i,r} Z_{a,s}^*}_{\text{Addressing Externalities}} = \underbrace{\sum_{s \in S_1} \pi_s^r (M_s^{i,r} - M_s^{h,r}) Z_{a,s}^*}_{\text{Distorting Risk-Sharing}}$$

  - See also Farhi and Werning [2016]
  - assumes exogenous constraints do not prevent reallocating asset

# Implementation Assumptions

1. Quantity regulations on intermediaries only (i.e. not on households)
   - e.g. capital and LTV requirements as opposed to fees and taxes
2. Intermediary $i^* \in \mathcal{I}$ unconstrained for intermediary-only assets $A^I$
   - e.g. derivatives lightly regulated

- Result: these assumptions are without loss of generality
- Implication: arbitrage between assets traded by $h$ and intermediary-only assets
- $A^*$: set of arbitrage-able assets
  - traded by households, replicating portfolio traded by $i$'s only
  - $w_{a'}(a)$: replicating portfolio weights, $Z_{a,s}(\cdot) = \sum_{a' \in A^I} w_{a'}(a) Z_{a',s}(\cdot)$

# Externalities as Arbitrage

**Proposition 1**
*The planner can implement the solution to the constrained planning problem using portfolio constraints on intermediaries only, and without constraining the trades of at least one intermediary, $i^* \in \mathcal{I}$, in the intermediary-only assets $A^I$.*

*In this implementation, for any arbitrage-able asset $a \in A^*$ that is tradable by household $h$,*

$$\underbrace{-Q_a + \sum_{a' \in A^I} w_{a'}(a) Q_{a'}}_{\text{arbitrage violation}} = \underbrace{\sum_{s \in S_1} \pi_s^r \Delta_s^{h,i^*,r} Z_{a,s}^*}_{\text{expected externality-weighted payoffs}} . \tag{1}$$

# Example

- Capital controls example based on Fanelli and Straub [2019]
- Initial state $s_0$, future states $S_1 = \{g, b\}$, probabilities $\pi_s^p$
- Goods $J_s = \{T, NT\}$, common discount factor $\beta$
- Tradables are numeraire, fixed domestic price index
  - exchange rate $e_s = (P_{NT,s})^{1-\alpha}$
- Ricardian and non-participant households, $H = \{r, n\}$
  - foreign ($a_{fc}$) and domestic ($a_{dc}$) risk-free bonds, tradable by $r$ but not $n$
  - Cobb–Douglas preferences over $T$ and $NT$, log utility
- Foreign intermediaries risk-neutral, only consume tradables
  - can trade int.-only f.c. bond $a_I$, currency forward $a_F$ at strike $F$

# Example Wedges

- Assumption: $n$ endowed with all non-tradables
  - $n$ also endowed with tradables, more in state $g$ than $b$
  - all other endowments same in both states
- $n$ cannot participate in markets, relative to $r$ has high MU in state $b$
- Planner wants to increase $P_{NT,b}$ to help $n$
  - $\mu_{NT,s}$: money-metric multiplier on market clearing constraint in planner's problem
  - key idea: if market-clearing prices max welfare, $\mu_{NT,s} = 0$ (first welfare theorem)
  - if not, pecuniary externalities don't cancel (in this case, b/c incomplete markets)
  - measure by "wedges" $\tau^p_{j,s}$, $\pi^p_s \tau^p_{NT,s} = -\frac{1}{2}\frac{\mu_{NT,s}}{P^*_{NT,s}}$
  - Geanakoplos and Polemarchakis [1986], Farhi and Werning [2016]

# Example Externalities and Arbitrage

- How to increase $P_{NT,b}$? transfer wealth foreign ints. $i$ to $r$
  - increase demand for non-tradable
  - Measure benefit ($\Delta_b^{r,i,p} > 0$):

$$\Delta_s^{r,i,p} = \sum_{j \in J_s} P^*_{j,s} \tau^p_{j,s} ( \underbrace{X^r_{I,j,s} - X^i_{I,j,s}}_{\text{change in demand due to income transfer}} )$$

- Implementation: limit foreign currency borrowing by $r$
  - cost: borrowing limit creates wedge between SDFs $M^r_s$ and $M^i_s$
  - arbitrage between fc/dc bonds traded by $r$ and forward/risk-free rates for $i$-only:

$$\underbrace{Q_{a_I} - Q_{a_{fc}}}_{\text{risk-free rate arbitrage}} = \pi^p_g \Delta^{r,i,p}_g + \pi^p_b \Delta^{r,i,p}_b,$$

$$\underbrace{F \times Q_{a_I} + Q_{a_F} - Q_{a_{dc}}}_{\text{CIP violation}} = \pi^p_g \Delta^{r,i,p}_g (P^*_{NT,g})^{1-\alpha} + \pi^p_b \Delta^{r,i,p}_b (P^*_{NT,b})^{1-\alpha}.$$

# Recovering Externalities

- Now imagine a financial economist who observes arbitrages for $a \in A^*$
  - preceding example: $A^* = \{a_{fc}, a_{dc}\}$
- Can we recover the externalities $\Delta_s^{h,i,r}$?
  - Defined with reference to some $\pi_s^r$
  - Possibly incomplete markets: more states than $a \in A^*$
- Idea: make externality-mimicking portfolio (EMP) whose returns are the (projected) externalities
- Use returns $R_{a,s} = \frac{Z_{a,s}}{Q_a}$, $R_{a,s}^I = (1 - \chi_a) R_{a,s}$,

$$\chi_a = \frac{-Q_a + \sum_{a' \in A^I} w_{a'}(a) Q_{a'}}{\sum_{a' \in A^I} w_{a'}(a) Q_{a'}}$$

# Example: Inverting the Arbitrages

- Example equations in matrix form:

$$\begin{bmatrix} \chi_{a_{fc}} \\ \chi_{a_{dc}} \end{bmatrix} = \begin{bmatrix} \pi_g^p R^I_{a_{fc},g} & \pi_b^p R^I_{a_{fc},b} \\ \pi_g^p R^I_{a_{dc},g} & \pi_b^p R^I_{a_{dc},b} \end{bmatrix} \cdot \begin{bmatrix} \Delta_g^{r,i,p} \\ \Delta_b^{r,i,p} \end{bmatrix}$$

- We want:

$$\begin{bmatrix} \Delta_g^{r,i,p} \\ \Delta_b^{r,i,p} \end{bmatrix} = \begin{bmatrix} R^I_{a_{fc},g} & R^I_{a_{dc},g} \\ R^I_{a_{fc},b} & R^I_{a_{dc},b} \end{bmatrix} \cdot \begin{bmatrix} \theta^*_{a_{fc}} \\ \theta^*_{a_{dc}} \end{bmatrix}.$$

- We solve:

$$\begin{bmatrix} \theta^*_{a_{fc}} \\ \theta^*_{a_{dc}} \end{bmatrix} = \underbrace{\left( \begin{bmatrix} R^I_{a_{fc},g} & R^I_{a_{dc},g} \\ R^I_{a_{fc},b} & R^I_{a_{dc},b} \end{bmatrix} \right)^{-1} \cdot \left( \begin{bmatrix} \pi_g^p R^I_{a_{fc},g} & \pi_b^p R^I_{a_{fc},b} \\ \pi_g^p R^I_{a_{dc},g} & \pi_b^p R^I_{a_{dc},b} \end{bmatrix} \right)^{-1}}_{\text{inverse second moment matrix of } R^I_{a,s}} \cdot \begin{bmatrix} \chi_{a_{fc}} \\ \chi_{a_{dc}} \end{bmatrix}$$

# Recovering Externalities

- This inversion is the projection of $\Delta_s^{h,i,r}$ on to the return space
  - $R^I_{a,s}$ and $R_{a,s}$ are the same return spaces
  - Like projecting an SDF on to payoff space (Hansen and Richard [1987])
  - uses standard "L2" projection
  - projection works without $A^*$ being a complete market
- Assume positive-price assets, one risk-free asset in $A^*$
  - e.g. price of 1 yen in one month, in USD today
- Expected return vector $\mu^{A^*,r}$ and cov. matrix $\Sigma^{A^*,r}$
  - for risky returns $R_{a,s}$; $\mu^{A^*,I,r}$ and $\Sigma^{A^*,I,r}$ for $R^I_{a,s}$
- Arbitrage vector $\chi^{A^*}$, risk-free arbitrage $\chi_f$, $R_f = (1-\chi_f)R^I_f$

# The Externality Mimicking Portfolio (EMP)

**Definition 1**

The externality-mimicking portfolio is a portfolio of the replicating portfolios of $A^*$, with weights on the risky replicating portfolios equal to

$$\theta^{A^*,r} = (\Sigma^{A^*,I,r})^{-1}(\chi^{A^*} - \chi_f \frac{\mu^{A^*,I,r}}{R_f^I}),$$

and a weight on the risk-free replicating portfolio equal to

$$\theta_f^{A^*,r} = -(\theta^{A^*,r})^T \frac{\mu^{A^*,I,r}}{R_f^I} + \frac{1}{(R_f^I)^2}\chi_f.$$

- defined as "portfolio of replicating portfolios" for $a \in A^*$

# The EMP as a Projection

The EMP has the following properties:

1. The externalities are the return on the externality mimicking portfolio plus a zero-mean residual:

$$\Delta_s^{h,i,r} = \sum_{a \in A^*} R_{a,s}^I \theta_a^{A^*,r} + \epsilon_s^{A^*,r},$$

$$\sum_{s \in S_1} \pi_s^r R_{a,s}^I \epsilon_s^{A^*,r} = 0 \; \forall a \in A^*.$$

2. The variance of the externalities under the reference measure, $\sum_{s \in S_1} \pi_s^r (\Delta_s^{h,i,r} - \frac{\chi_f}{R_f^I})^2$, is weakly greater than the variance of the externality-mimicking portfolio's return, $(\theta^{A^*,r})^T \Sigma^{A^*,I,r} \theta^{A^*,r}$.

# HJ Bounds and the EMP

3. Let $m_s^{l,r}$ be any SDF that prices the replicating portfolios under the measure $\pi_s^r$. Then $m_s^r = m_s^{l,r} + \sum_{a \in A^*} R_{a,s}^l \theta_a^{A^*,r}$ is the solution to the problem:

$$\min_{m \in \mathbb{R}^{|S_1|}} \sum_{s \in S_1} \pi_s^r (m_s - m_s^{l,r})^2 \text{ subject to}$$
$$\sum_{s \in S_1} \pi_s^r m_s R_{a,s} = 1 \; \forall a \in A^*.$$

4. The Sharpe ratio due to arbitrage,

$$\hat{S}^{A^*,l,r}(\theta) = \frac{\theta^T \cdot (\chi^{A^*} - \chi_f \frac{\mu^{A^*,l,r}}{R_f^l})}{(\theta^T \Sigma^{A^*,l,r} \theta)^{\frac{1}{2}}}$$

is maximal for the EMP among portfolios of replicating portfolios of assets in $A^*$.

# Interpretation

- Portfolio (generally) has negative returns when $\Delta_s^{h,i,r}$ is negative
  - Planner wants to transfer wealth to ints from households
  - -10%: for planner, \$1 loss for $h$ is ~\$1.1 gain for $i$
  - because this fixes externalities
- Analogy: Revealed Preference
- Which reference measure to use?
  - Two obvious choices: physical $\pi_s^p$ and risk-neutral $\pi_s^q$
  - $\pi_s^p \Delta_s^{h,i,p} = \pi_s^q \Delta_s^{h,i,q}$

# The EMP Ingredients

Constructing the externality-mimicking portfolio requires three ingredients:

1. A set of arbitrage-able assets $A^*$,
2. Prices for both the arbitrage-able assets in $A^*$ and their replicating portfolios, and
3. Expected returns and a variance-covariance matrix for the assets in $A^*$.

- using risk-neutral measure convenient b/c expected returns = risk free rate
  - but will still need expected returns later
- can get risk-neutral cov. matrix from options (at least for currencies)
- constructing the EMP is easy; the next step is to use it

# Expected Return Test

- What should the covariance be between $\Delta_s^{h,i,q}$ and $\frac{\pi_s^q}{\pi_s^p}$ be?
  - bad times: $\Delta_s^{h,i,q}$ negative, SDF high?
  - Covariance should be negative
- Observe:

$$Cov^p(\frac{\pi_s^i}{\pi_s^p}, \Delta_s^{h,i,i}) = (\frac{\tilde{\chi}_f}{R_f^I} - \sum_{s \in S_1} \pi_s^p \Delta_s^{h,i,i})$$

$$= -(\theta^{A^*,i})^T \cdot (\mu^{A^*,I,p} - R_f^I) + Cov^p(\frac{\pi_s^i}{\pi_s^p}, \epsilon_s^{A^*,i}).$$

- Simple test: check excess returns on tracking portfolio
  - Should be positive, subject to "unspanned externalities"

# Stress Return Test

- What should $\Delta_s^{h,i,q}$ be in the Fed's stress test scenario?
  - Stress test scenario is when Fed wants intermediaries to have more wealth
  - Intermediaries must trade with households to make this happen
  - Therefore, $\Delta_s^{h,i,q}$ negative in the stress scenario
- Stress tests conducted annually
  - Stress test scenarios from Fed website
  - Consider one and four quarter returns
  - But pretend they happen in one month

# Empirical Strategy

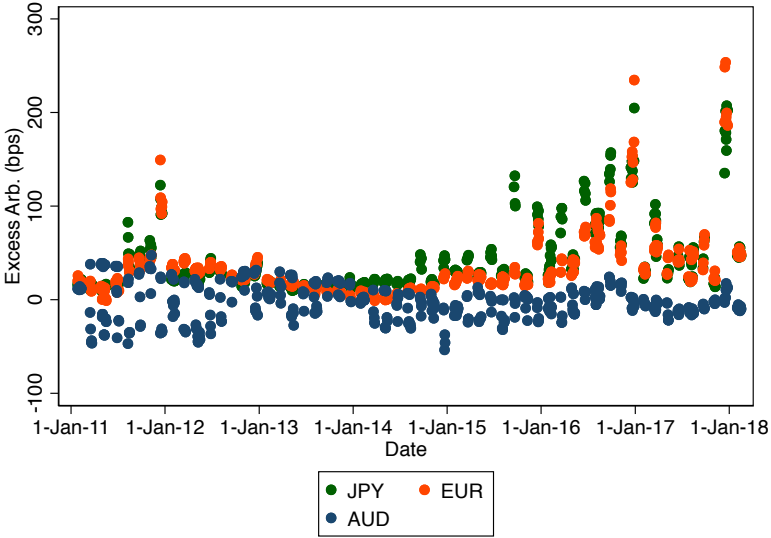
- Use \$/Euro, \$/AUD, and \$/Yen in Portfolio
  - IOER and OIS rates are risk-free rates
  - $\Sigma^q$ is covariance matrix using intermediary risk-neutral measure
  - Use 1-month atm-option-implied variance-covariance
- Look at arbitrages at daily frequency
  - Use a one-month horizon
  - Look only at dates $> 1m$ before FOMC meeting
- Expected returns: assume log exchange rates are random walks

# Summary Statistics

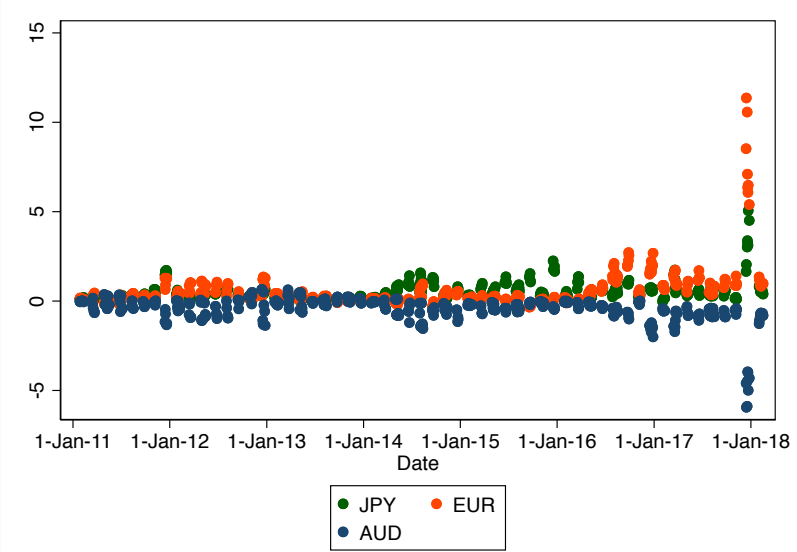
**Table 1:** Summary Statistics for Arbitrage

| | Pounds | Euros | Yen | AUD | OIS-IOER |
|---|---|---|---|---|---|
| Arbitrage Mean (bps/year) | 6.7 | 22.4 | 28.3 | -15.4 | -12.5 |
| Arbitrage SD (bps/year) | 28.2 | 37.7 | 37.2 | 18.5 | 2.8 |
| OI Vol. (bps/year) | 859 | 950 | 977 | 1073 | - |
| OI Corr. with Pound/USD | 1.00 | 0.56 | 0.22 | 0.47 | - |
| OI Corr. with Euro/USD | 0.56 | 1.00 | 0.31 | 0.51 | - |
| OI Corr. with Yen/USD | 0.22 | 0.31 | 1.00 | 0.26 | - |
| Empirical Corr. with SPDR | 0.23 | 0.10 | -0.34 | 0.37 | - |
| Empirical Corr. with HKM | 0.26 | 0.17 | -0.31 | 0.31 | - |
| N | 444 | 444 | 444 | 444 | 444 |

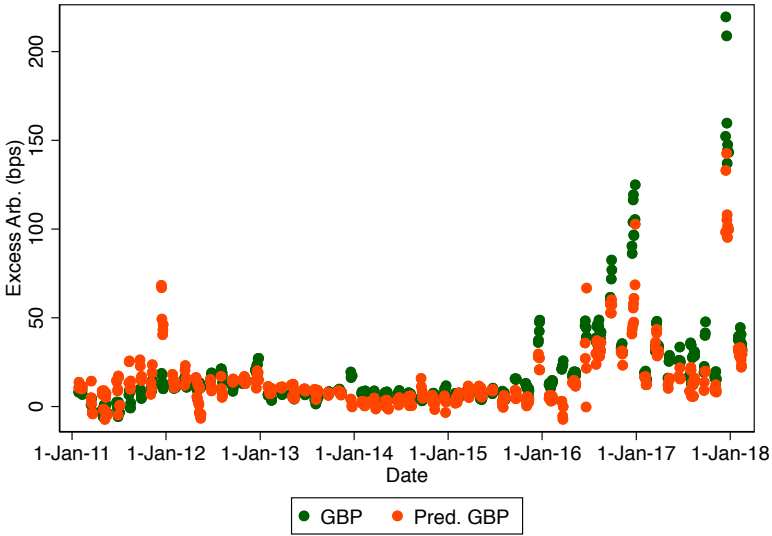
# Time Series of Excess Arbitrage



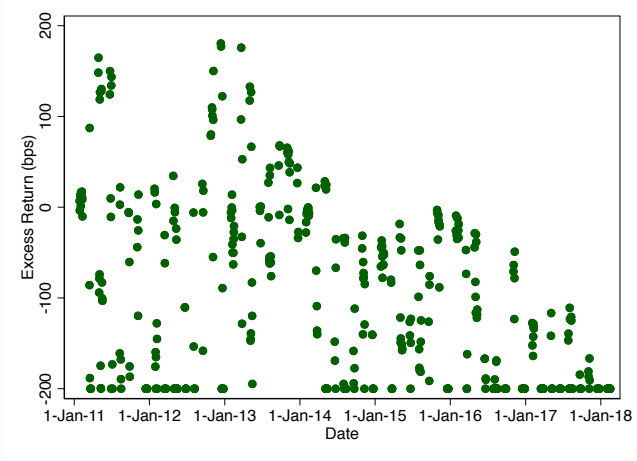
# Externality Mimicking Portfolio Weights



# Predicting Pound Arbitrage



# Test #1: Expected Return




Note: top-coded at +/- 200% (esp. YE 2017)

# Test #1: Expected Return

**Table 2:** Risk-Neutral EMP Expected Returns

| | N | Mean (bps) | Standard Deviation (bps) | Test | P-Value |
|---|---|---|---|---|---|
| Full Sample | 444 | -222 | 25.9 | $\geq 0$ | 0.0000 |
| Quarter-Ends | 155 | -431 | 69.7 | $\geq 0$ | 0.0000 |
| Year-Ends | 46 | -1005 | 209.2 | $\geq 0$ | 0.0000 |
| QE - NQE | | -321 | | $= 0$ | 0.0000 |
| YE - NYE QE | | -816 | | $= 0$ | 0.0000 |

# Stress Test Scenarios

**Table 3:** Stress Test "Severely Adverse" Scenarios

| | Euro | | Stocks | | Yen | | AUD* | *Imputed |
|---|---|---|---|---|---|---|---|---|
| Stress Test Date | One-Quarter Return | Four-Quarter Return | One-Quarter Return | Four-Quarter Return | One-Quarter Return | Four-Quarter Return | One-Quarter Return | Four-Quarter Return |
| 9/30/12 | -7.7 | -15.4 | -19.3 | -51.5 | 2.8 | -1.0 | -8.8 | -24.5 |
| 9/30/13 | -14.3 | -21.4 | -26.5 | -49.5 | 3.1 | -1.1 | -17.2 | -28.7 |
| 9/30/14 | -12.0 | -13.4 | -16.3 | -57.1 | 7.6 | 6.5 | -5.1 | -17.2 |
| 12/31/15 | -7.7 | -13.9 | -20.2 | -50.7 | 2.7 | 5.1 | -7.7 | -18.3 |
| 12/31/16 | -9.1 | -11.9 | -34.0 | -49.7 | 3.3 | 7.5 | -17.0 | -24.1 |
| 12/31/17 | -6.6 | -10.9 | -51.3 | -62.8 | 11.7 | 4.6 | -23.7 | -32.9 |

# Test #2: Stress Test Returns

**Table 4:** Risk-Neutral Returns in Stress Scenario

| Stress Test Date | N | Mean (1Q,%) | S.D. (1Q,%) | P-value (1Q) | Mean (4Q,%) | S.D. (4Q,%) | P-value (4Q) |
|---|---|---|---|---|---|---|---|
| 9/30/12 | 63 | -0.8 | 0.3 | 0.9923 | -1.8 | 1.0 | 0.9593 |
| 9/30/13 | 59 | -0.9 | 0.4 | 0.9838 | -2.1 | 0.7 | 0.9987 |
| 9/30/14 | 62 | 4.8 | 0.6 | 0.0000 | 9.9 | 1.0 | 0.0000 |
| 12/31/15 | 60 | 1.9 | 0.4 | 0.0000 | 4.5 | 0.8 | 0.0000 |
| 12/31/16 | 61 | 2.8 | 0.8 | 0.0000 | 7.0 | 1.2 | 0.0000 |
| 12/31/17 | 45 | 31.4 | 5.0 | 0.0000 | 28.6 | 4.3 | 0.0000 |

# Robustness

- Use physical-measure and stress-test returns
  - similar results
- Add in equity-related arbitrage (SPDR vs SPY options)
  - expected return test similar, stress tests look better sometimes
- Use "dollar" and "carry" factors instead of specific currencies vs. USD
  - as in Lustig et al. [2011]
  - results similar
  - EMP is short dollar (makes sense), short carry (does not make sense)

# Conclusion

- Under optimal policy, externalities appear as arbitrage
- Allows for revealed-preference exercise
- The EMP recovers externalities from observed arbitrage
- The externalities I recover do not fit with basic intuition
  - data: arb $<0$ for AUD, $>0$ for JPY– should be reverse
- Speculation: the problem is leverage constraints
  - leverage constraints don't account for signs
  - customer demand for carry trade (Du et al. [2018])
  - i.e. customers want to take macro risk
  - but leverage ratios keep this risk inside banking system

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