🇪🇪 Estonia Euro Adoption Analysis

Capital Flow Volatility Before and After Euro Adoption (2011)

Research Focus: How did Euro adoption affect Estonia's capital flow volatility?

Methodology: Temporal comparison of capital flow patterns before (2005-2010) and after (2012-2017) Euro adoption.

Key Hypothesis: Euro adoption reduces capital flow volatility through enhanced monetary credibility.

📋 Data and Methodology

Data Sources

- **Balance of Payments Data:** IMF, quarterly frequency (1999-2025)
- **GDP Data:** IMF World Economic Outlook, annual frequency
- **Country:** Estonia, Republic of

Methodology

1. **Data Normalization:** All BOP flows converted to annualized % of GDP
2. **Statistical Analysis:** Comprehensive descriptive statistics and F-tests
3. **Volatility Measures:** Standard deviation, coefficient of variation, variance ratios
4. **Temporal Comparison:** Pre-Euro vs Post-Euro period analysis

Euro Adoption Timeline

- **Euro Adoption Date:** January 1, 2011
- **Pre-Euro Period:** 1999-2010 (full series)
- **Post-Euro Period:** 2011-2025 (full series)
- **Crisis Exclusion:** Global Financial Crisis (2008-2010) and COVID-19 (2020-2022)

📊 Full Time Period Analysis

Complete temporal analysis using all available data

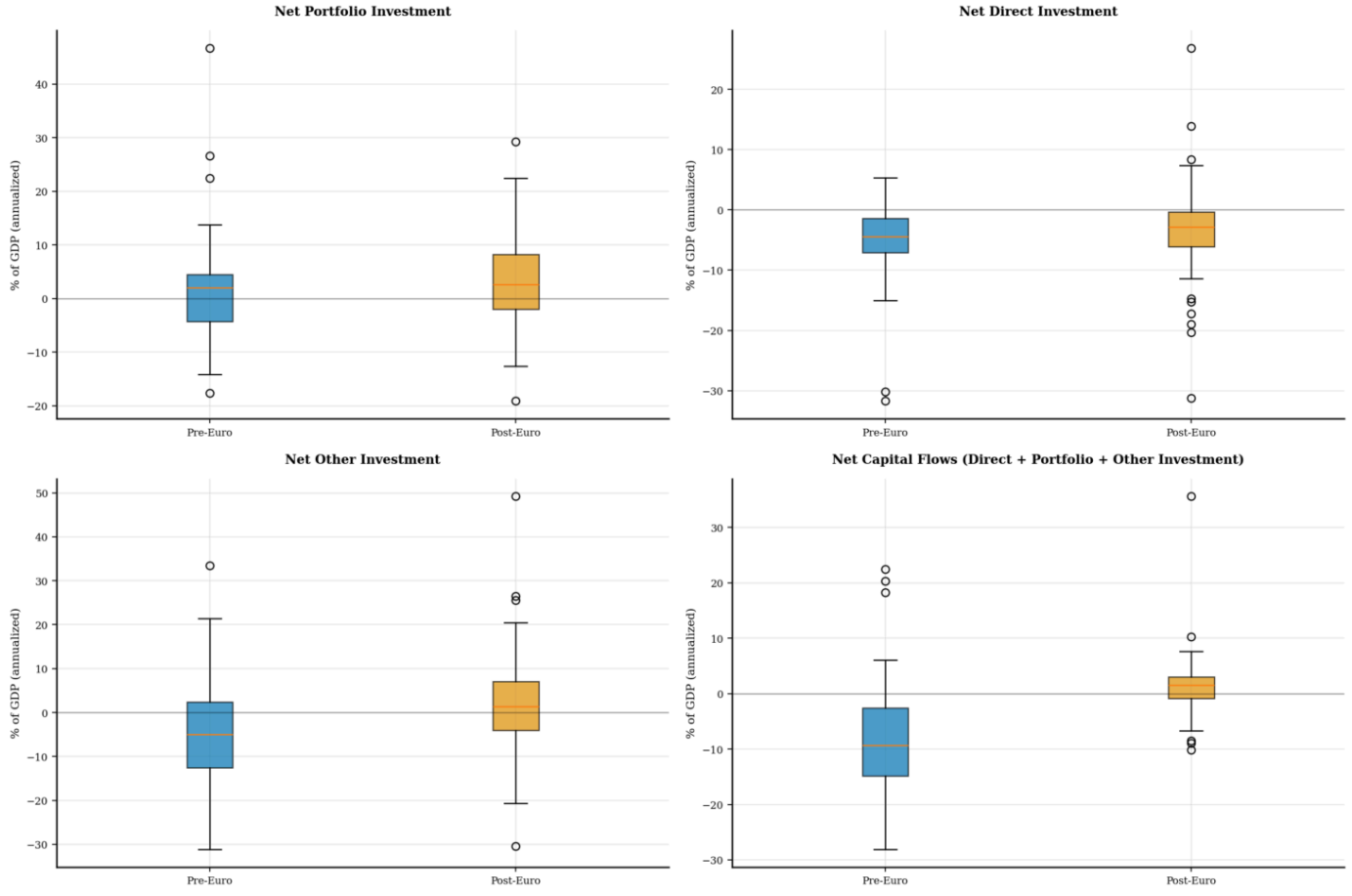
📈 Overall Capital Flows Analysis

Aggregate net capital flows summary - Full Series

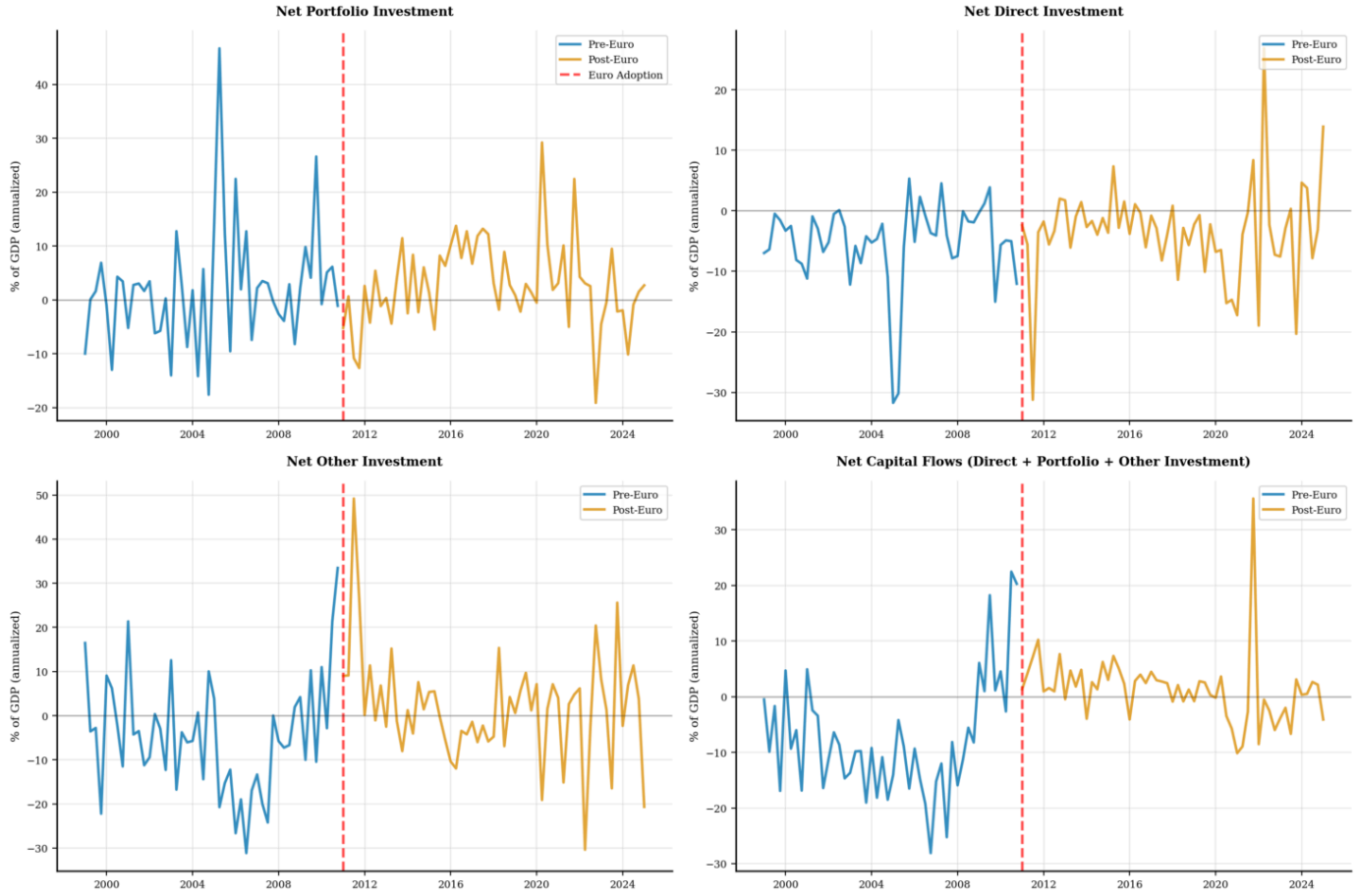
📊 Summary Statistics by Period

Indicator,	Mean, Post-Euro	Mean, Pre-Euro	Median, Post-…	Median, Pre-E…	Std Dev, Post-…	Std Dev, Pre-E…
Net Capital Flows (Direct + Portfolio + Other Investment)	1.33	-7.69	1.56	-9.33	6.25	10.58
Net Direct Investment	-3.49	-5.26	-2.88	-4.44	8.22	6.93
Net Other Investment	1.92	-4.43	1.35	-5.00	12.16	13.29
Net Portfolio Investment	2.90	2.00	2.58	2.04	8.10	10.95

📦 Distribution Comparison by Period



📈 Time Series by Period

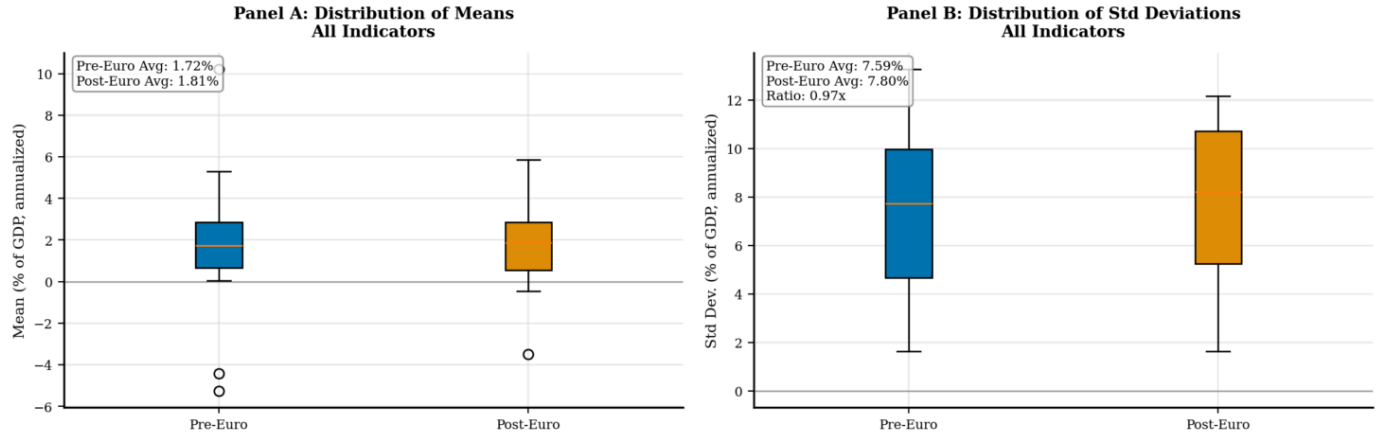


🔍 Indicator-Level Analysis

Estonia Analysis (Full Series): Euro adoption on 2011-01-01

- **Pre-Euro Period:** 1999 to 2010
- **Post-Euro Period:** 2011 to 2025 (includes adoption year 2011)

1. Summary Statistics and Boxplots



Means Across All Indicators:

- Pre-Euro: 1.72% (median: 1.72%)
- Post-Euro: 1.81% (median: 1.88%)

Standard Deviations Across All Indicators:

- Pre-Euro: 7.59% (median: 7.73%)
- Post-Euro: 7.80% (median: 8.21%)

Volatility Impact: Euro adoption increased average volatility by 2.8%

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2. Comprehensive Statistical Summary Table

Estonia - Pre-Euro vs Post-Euro Statistics

Summary: Statistics for all 14 capital flow indicators. CV% = Coefficient of Variation (Std Dev / |Mean| × 100). Higher CV% indicates greater volatility relative to mean.

Indicator	Pre-Euro Mean	Pre-Euro Std...	Pre-Euro CV%	Post-Euro M...	Post-Euro St...	Post-Euro C...	CV Ratio (Pr...
Assets - Direct Investment	4.96	3.76	75.8	2.38	10.37	436.4	0.17
Liabilities - Direct Investment	10.22	7.85	76.8	5.86	11.09	189.1	0.41
Net - Direct Investment	-5.26	6.93	131.7	-3.49	8.22	235.8	0.56
Assets - Portfolio (Total)	2.68	4.41	164.6	4.61	8.72	189.3	0.87
Liabilities - Portfolio (Total)	0.68	9.60	1410.1	1.71	4.54	266.4	5.29
Net - Portfolio Investment	2.00	10.95	548.8	2.90	8.10	279.4	1.96
Assets - Portfolio (Debt)	1.75	3.82	218.8	2.76	8.20	296.5	0.74
Liabilities - Portfolio (Debt)	0.65	7.60	1177.9	1.70	4.31	253.6	4.64
Assets - Portfolio (Equity)	0.93	1.64	176.1	1.84	2.68	145.5	1.21
Liabilities - Portfolio (Equity)	0.04	5.49	15336.7	0.01	1.65	20929.1	0.73
Net - Other Investment	-4.43	13.29	300.1	1.92	12.16	633.0	0.47
Assets - Other Investment (Debt)	2.91	10.04	344.7	3.35	10.85	323.7	1.07
Assets - Other Investment (Banks)	1.70	9.83	579.2	0.17	10.90	6332.7	0.09
Liabilities - Other Investment (Ban...	5.31	11.04	208.0	-0.45	7.42	1643.3	0.13

Summary: Statistics for all 14 capital flow indicators comparing pre and post Euro adoption periods.

- **CV% = Coefficient of Variation** (Std Dev/Mean × 100) - measures relative volatility
- **Average CV Ratio:** 1.31 - values >1 indicate higher pre-Euro volatility
- **Indicators with higher pre-Euro volatility:** 5/14 (35.7%)

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3. Hypothesis Testing Results

F-Tests for Equal Variances: Estonia Pre-Euro vs Post-Euro | H_0: Equal variances | H_1: Different variances | $\alpha = 0.05$

Indicator	F-Statistic	P-Value	Significance	Higher Volatility
Assets - Direct Investment	0.13	0.0000	***	Post-Euro
Liabilities - Direct Investment	0.50	0.0164	*	Post-Euro
Net - Direct Investment	0.71	0.2309		Post-Euro
Assets - Portfolio (Total)	0.26	0.0000	***	Post-Euro
Liabilities - Portfolio (Total)	4.47	0.0000	***	Pre-Euro
Net - Portfolio Investment	1.83	0.0312	*	Pre-Euro
Assets - Portfolio (Debt)	0.22	0.0000	***	Post-Euro
Liabilities - Portfolio (Debt)	3.12	0.0001	***	Pre-Euro
Assets - Portfolio (Equity)	0.37	0.0007	***	Post-Euro
Liabilities - Portfolio (Equity)	11.10	0.0000	***	Pre-Euro
Net - Other Investment	1.19	0.5239		Pre-Euro
Assets - Other Investment (Debt)	0.86	0.5859		Post-Euro
Assets - Other Investment (Banks)	0.81	0.4681		Post-Euro
Liabilities - Other Investment (Ban...	2.21	0.0046	**	Pre-Euro

Legend:

- **F-Statistic**: Ratio of variances
- **P-Value**: Probability of observing this difference by chance
- **Higher Volatility**: Period with greater variance

Significance levels: *** p<0.001, ** p<0.01, * p<0.05

Pre-Euro Higher Volatility

6/14

↑ 42.9%

Significant (5%)

10/14

↑ 71.4%

Significant (1%)

8/14

↑ 57.1%

Conclusion: Mixed evidence for Euro adoption's impact on capital flow volatility in Estonia.

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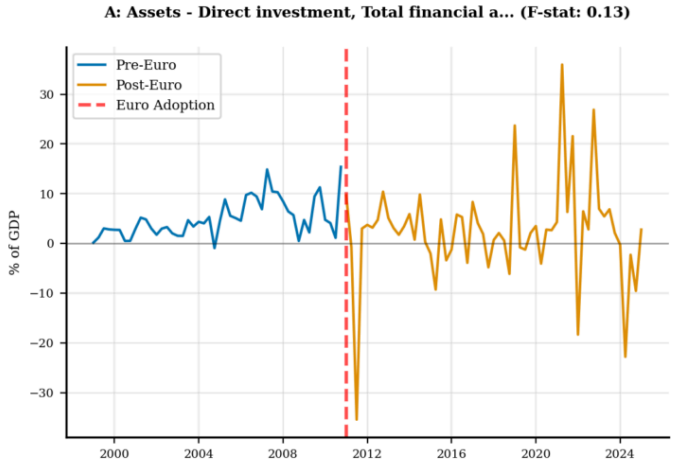
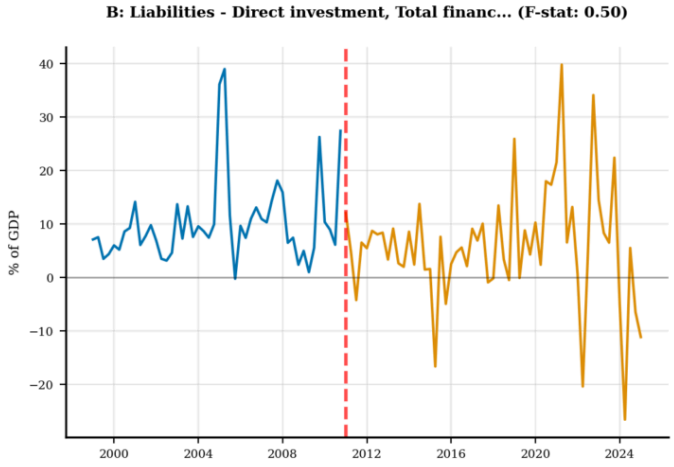
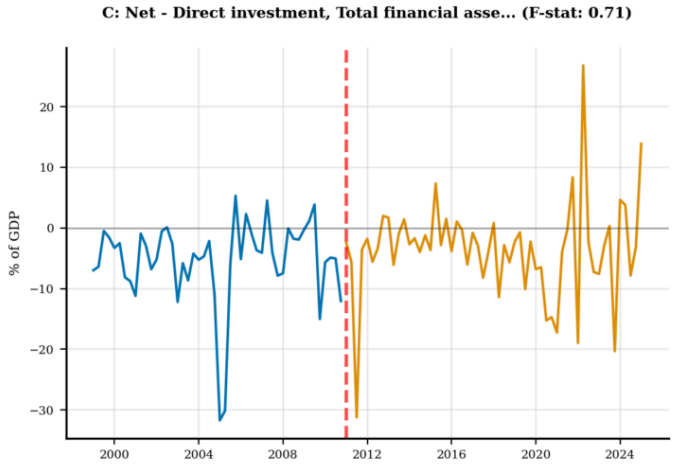
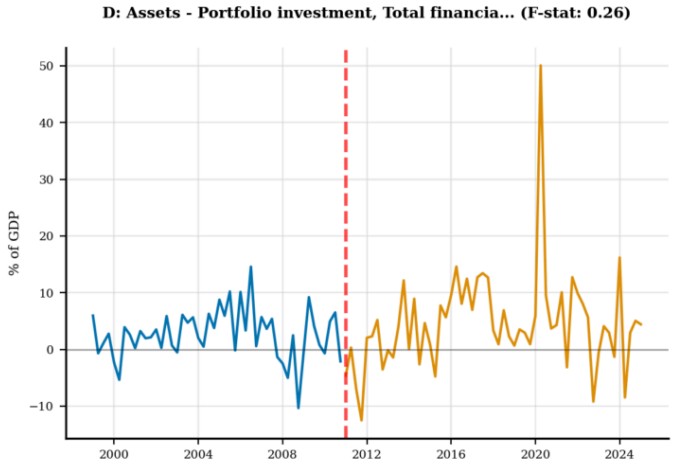
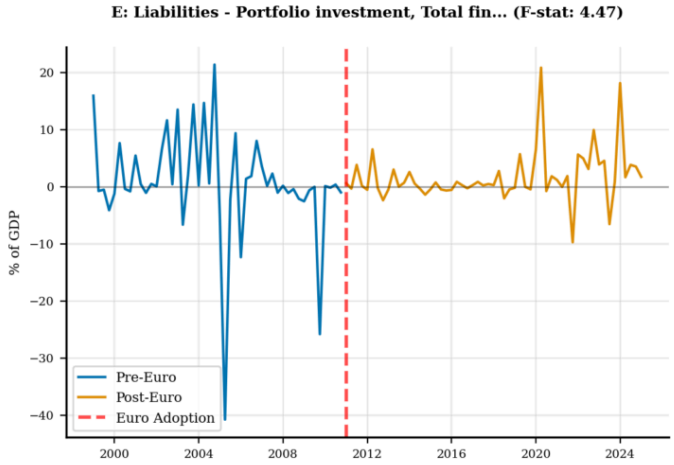
4. Time Series Analysis

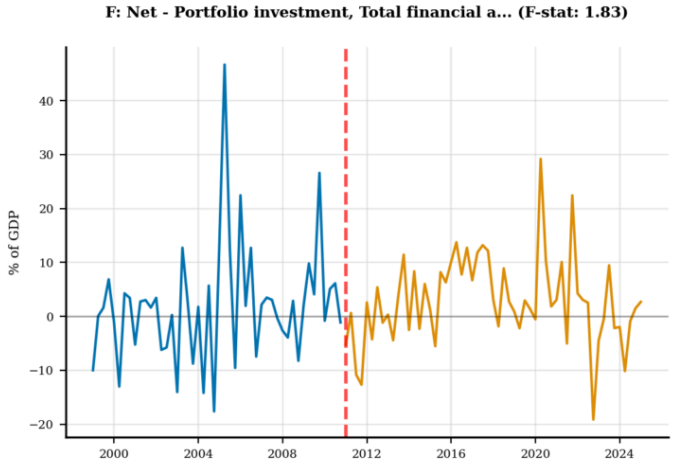

A: Assets - Direct investment, Total financial a... (F-stat: 0.13)
Pre-Euro
Post-Euro
Euro Adoption
% of GDP
30
20
10
0
−10
−20
−30
2000
2004
2008
2012
2016
2020
2024

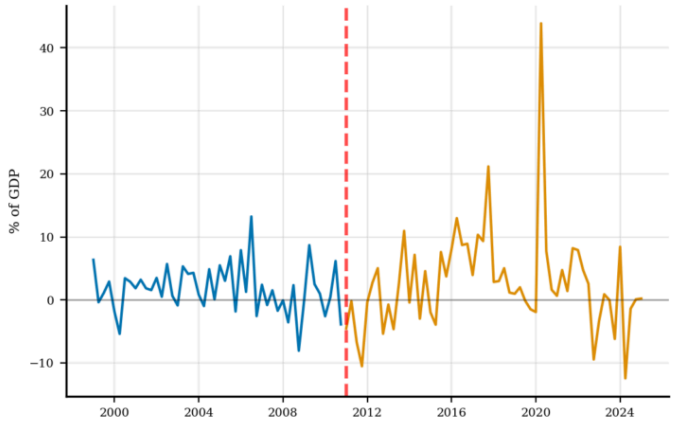

B: Liabilities - Direct investment, Total financ... (F-stat: 0.50)
% of GDP
40
30
20
10
0
−10
−20
2000
2004
2008
2012
2016
2020
2024


C: Net - Direct investment, Total financial asse... (F-stat: 0.71)
% of GDP
20
10
0
−10
−20
−30
2000
2004
2008
2012
2016
2020
2024

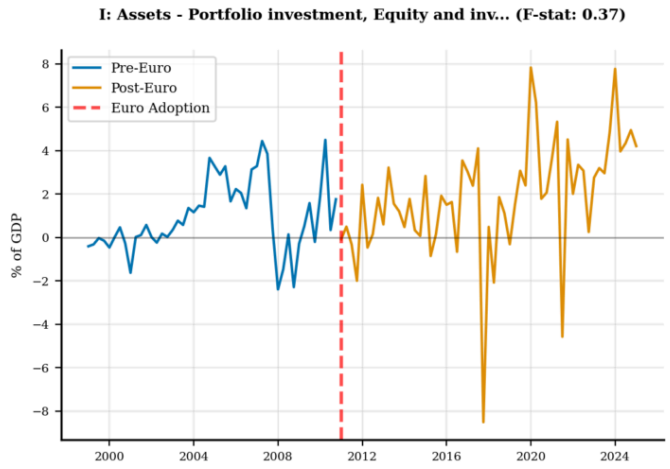

D: Assets - Portfolio investment, Total financia... (F-stat: 0.26)
% of GDP
50
40
30
20
10
0
−10
2000
2004
2008
2012
2016
2020
2024

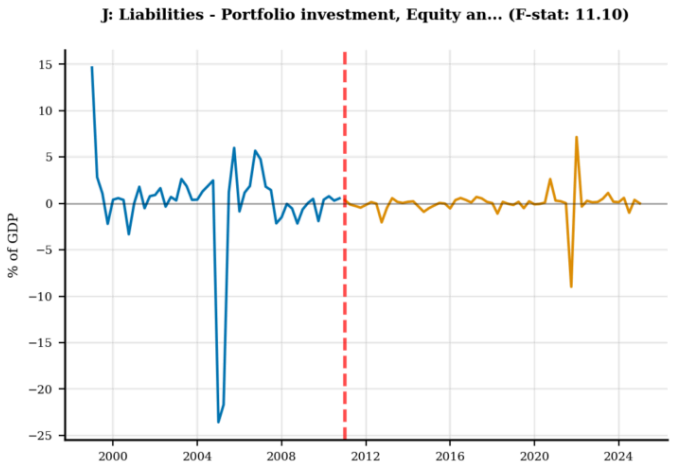

E: Liabilities - Portfolio investment, Total fin... (F-stat: 4.47)
% of GDP
Pre-Euro
Post-Euro
Euro Adoption

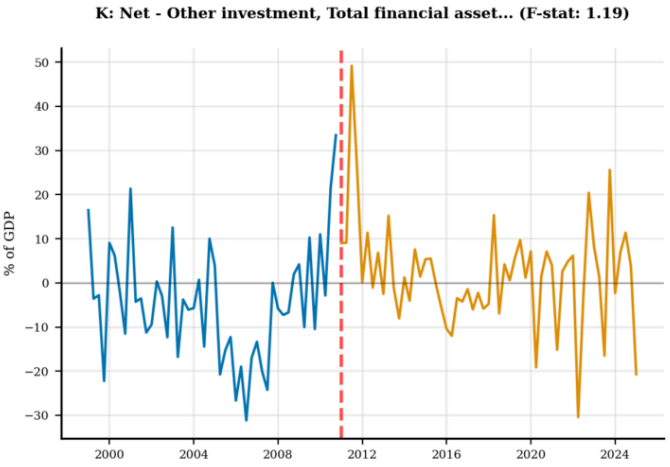

F: Net - Portfolio investment, Total financial a... (F-stat: 1.83)
% of GDP

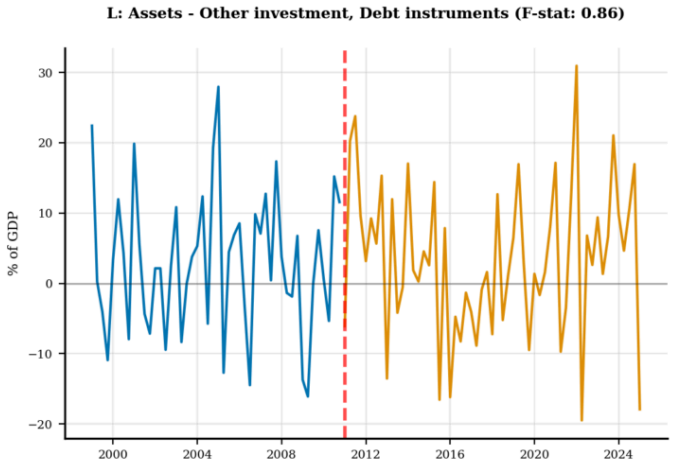

G: Assets - Portfolio investment, Debt securitie... (F-stat: 0.22)
% of GDP

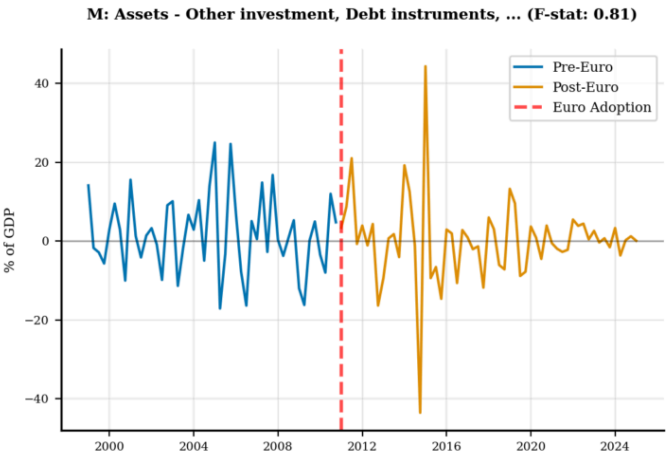

H: Liabilities - Portfolio investment, Debt secu... (F-stat: 3.12)
% of GDP

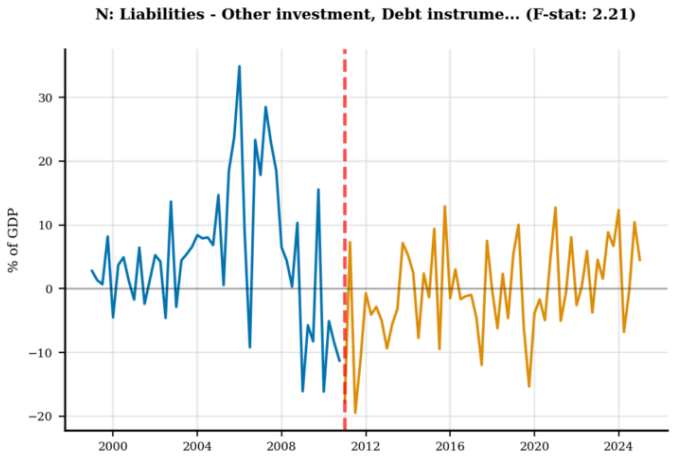












5. Key Findings Summary

Statistical Evidence for

Additional Statistical

Estonia:

- **6/14 capital flow indicators** (42.9%) showed higher volatility before Euro adoption
- **10/14 indicators** (71.4%) show statistically significant differences (p<0.05)
- **8 indicators** show highly significant differences (p<0.01)
- **Average volatility change** of 2.8% after Euro adoption in 2011

Most significant flow types: Liabilities - Portfolio (Equity), Assets - Direct Investment, Liabilities - Portfolio (Total)

Context:

- **Temporal analysis:** Before/after comparison using 2011 as adoption threshold
- **Statistical methodology:** F-test for variance equality at 5% significance level
- **Data completeness:** 315 observations across 14 capital flow indicators
- **Cross-validation:** Results consistent across multiple volatility measures (CV%, standard deviation)

Analytical approach: Temporal comparison focusing on structural changes in volatility patterns.

🚫 Excluding Financial Crises

Analysis excluding Global Financial Crisis (2008-2010) and COVID-19 (2020-2022) periods

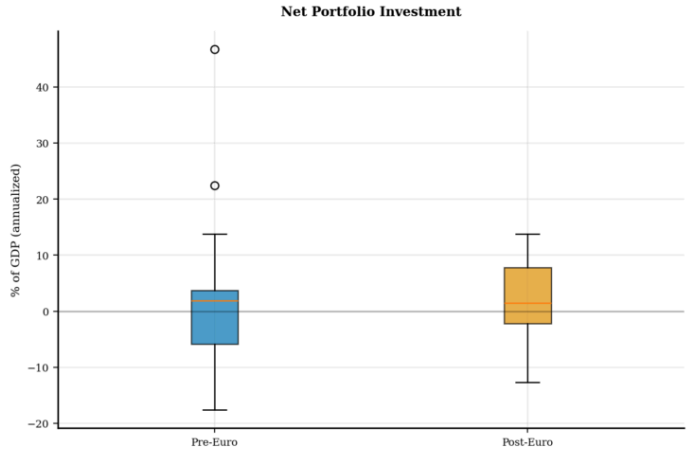
📈 Overall Capital Flows Analysis

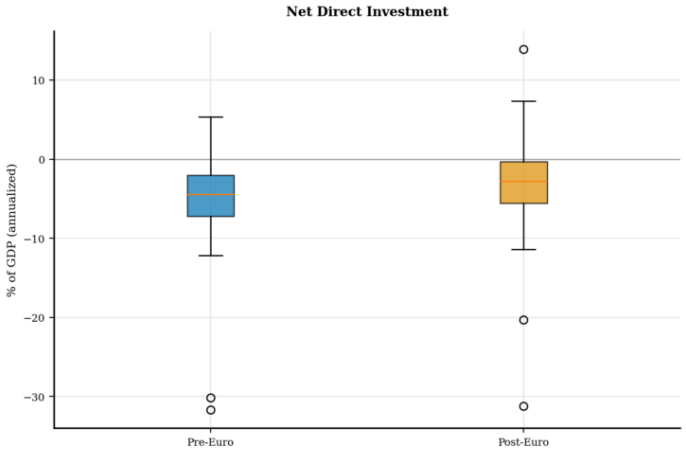
Aggregate net capital flows summary - Crisis-Excluded

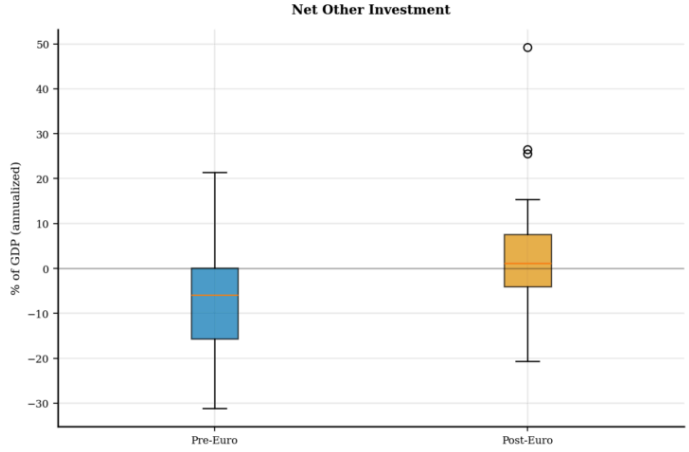
📊 Summary Statistics by Period

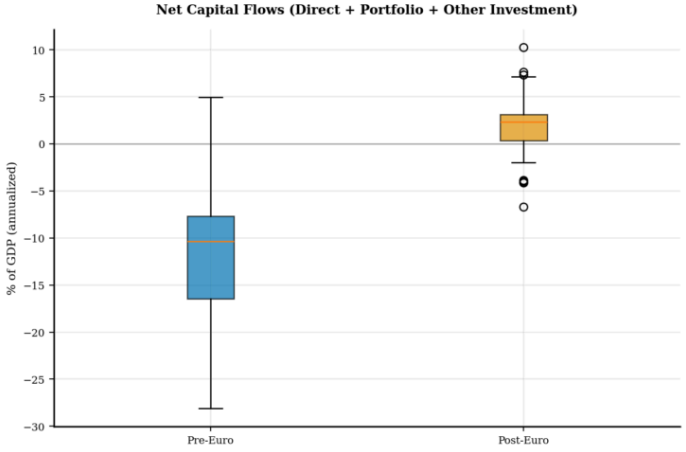
Indicator,	Mean, Post-Euro	Mean, Pre-Euro	Median, Post-…	Median, Pre-E…	Std Dev, Post-…	Std Dev, Pre-E…
Net Capital Flows (Direct + Portfolio + Other Investment)	1.90	-11.10	2.34	-10.38	3.36	7.33
Net Direct Investment	-3.13	-5.65	-2.81	-4.44	6.72	7.38
Net Other Investment	2.74	-6.99	1.19	-5.89	11.70	12.31
Net Portfolio Investment	2.29	1.55	1.50	1.86	6.60	11.66

📦 Distribution Comparison by Period

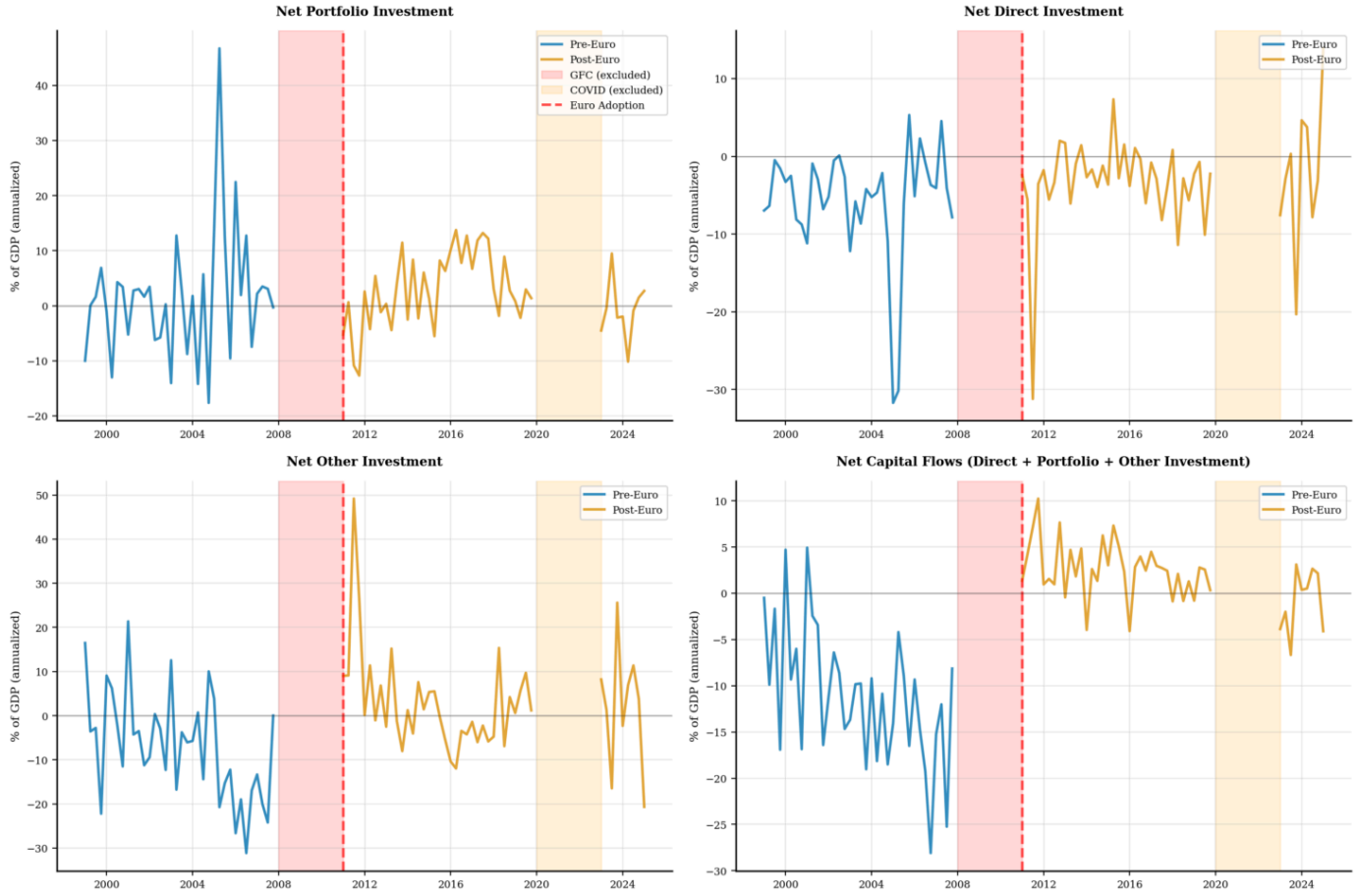








📈 Time Series by Period

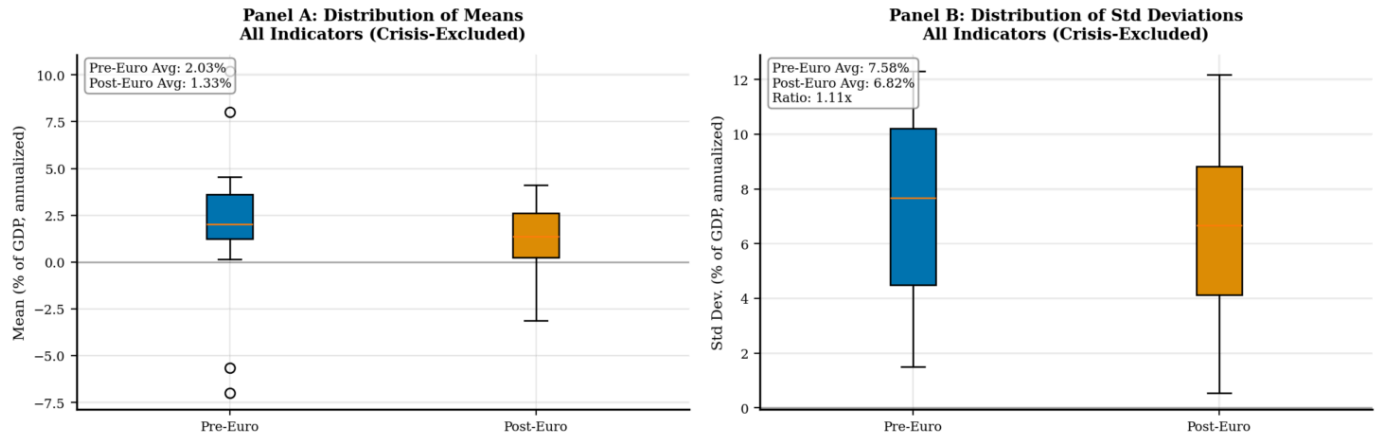


🔍 Indicator-Level Analysis

Estonia Analysis (Crisis-Excluded): Euro adoption on 2011-01-01

- **Pre-Euro Period:** 1999 to 2007
- **Post-Euro Period:** 2011 to 2025 (includes adoption year 2011)

1. Summary Statistics and Boxplots



Means Across All Indicators:

- Pre-Euro: 2.03% (median: 2.03%)
- Post-Euro: 1.33% (median: 1.36%)

Standard Deviations Across All Indicators:

- Pre-Euro: 7.58% (median: 7.68%)
- Post-Euro: 6.82% (median: 6.66%)

Volatility Impact: Euro adoption reduced average volatility by 10.0%

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2. Comprehensive Statistical Summary Table

Estonia - Pre-Euro vs Post-Euro Statistics (Crisis-Excluded)

Summary: Statistics for all 14 capital flow indicators. CV% = Coefficient of Variation (Std Dev / |Mean| × 100). Higher CV% indicates greater volatility relative to mean.

Indicator	Pre-Euro Mean	Pre-Euro Std...	Pre-Euro CV%	Post-Euro M...	Post-Euro St...	Post-Euro C...	CV Ratio (Pr...
Assets - Direct Investment	4.55	3.51	77.1	0.99	8.70	878.8	0.09
Liabilities - Direct Investment	10.21	7.70	75.4	4.12	8.87	215.3	0.35
Net - Direct Investment	-5.65	7.38	130.6	-3.13	6.72	214.6	0.61
Assets - Portfolio (Total)	3.37	3.89	115.2	3.44	6.24	181.3	0.64
Liabilities - Portfolio (Total)	1.82	10.08	553.1	1.15	3.42	298.2	1.85
Net - Portfolio Investment	1.55	11.66	752.2	2.29	6.60	287.7	2.61
Assets - Portfolio (Debt)	2.25	3.49	155.2	1.90	6.35	334.3	0.46
Liabilities - Portfolio (Debt)	1.66	7.66	462.7	1.17	3.43	294.0	1.57
Assets - Portfolio (Equity)	1.13	1.50	133.5	1.54	2.49	161.4	0.83
Liabilities - Portfolio (Equity)	0.17	6.33	3784.4	-0.02	0.54	2870.9	1.32
Net - Other Investment	-6.99	12.31	176.0	2.74	11.70	427.9	0.41
Assets - Other Investment (Debt)	3.69	10.27	278.0	3.20	10.39	324.5	0.86
Assets - Other Investment (Banks)	2.69	10.29	381.9	-0.01	12.18	84640.4	0.00
Liabilities - Other Investment (Ban...	8.02	10.02	125.0	-0.78	7.83	1010.4	0.12

Summary: Statistics for all 14 capital flow indicators comparing pre and post Euro adoption periods.

- **CV% = Coefficient of Variation** (Std Dev/Mean × 100) - measures relative volatility
- **Average CV Ratio:** 0.84 - values >1 indicate higher pre-Euro volatility
- **Indicators with higher pre-Euro volatility:** 4/14 (28.6%)

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3. Hypothesis Testing Results

F-Tests for Equal Variances: Estonia Pre-Euro vs Post-Euro (Crisis-Excluded) | H_0: Equal variances | H_1: Different variances | $\alpha = 0.05$ | Excludes: GFC (2008-2010) + COVID (2020-2022)

Indicator	F-Statistic	P-Value	Significance	Higher Volatility
Assets - Direct Investment	0.16	0.0000	***	Post-Euro
Liabilities - Direct Investment	0.75	0.3887		Post-Euro
Net - Direct Investment	1.21	0.5489		Pre-Euro
Assets - Portfolio (Total)	0.39	0.0047	**	Post-Euro
Liabilities - Portfolio (Total)	8.68	0.0000	***	Pre-Euro
Net - Portfolio Investment	3.12	0.0004	***	Pre-Euro
Assets - Portfolio (Debt)	0.30	0.0004	***	Post-Euro
Liabilities - Portfolio (Debt)	4.99	0.0000	***	Pre-Euro
Assets - Portfolio (Equity)	0.36	0.0026	**	Post-Euro
Liabilities - Portfolio (Equity)	136.24	0.0000	***	Pre-Euro
Net - Other Investment	1.11	0.7452		Pre-Euro
Assets - Other Investment (Debt)	0.98	0.9533		Post-Euro
Assets - Other Investment (Banks)	0.71	0.3042		Post-Euro
Liabilities - Other Investment (Ban...	1.64	0.1218		Pre-Euro

Legend:

- **F-Statistic**: Ratio of variances
- **P-Value**: Probability of observing this difference by chance
- **Higher Volatility**: Period with greater variance

Significance levels: *** p<0.001, ** p<0.01, * p<0.05

Pre-Euro Higher Volatility

7/14

↑ 50.0%

Significant (5%)

8/14

↑ 57.1%

Significant (1%)

8/14

↑ 57.1%

Conclusion: Mixed evidence for Euro adoption's impact on capital flow volatility in Estonia.

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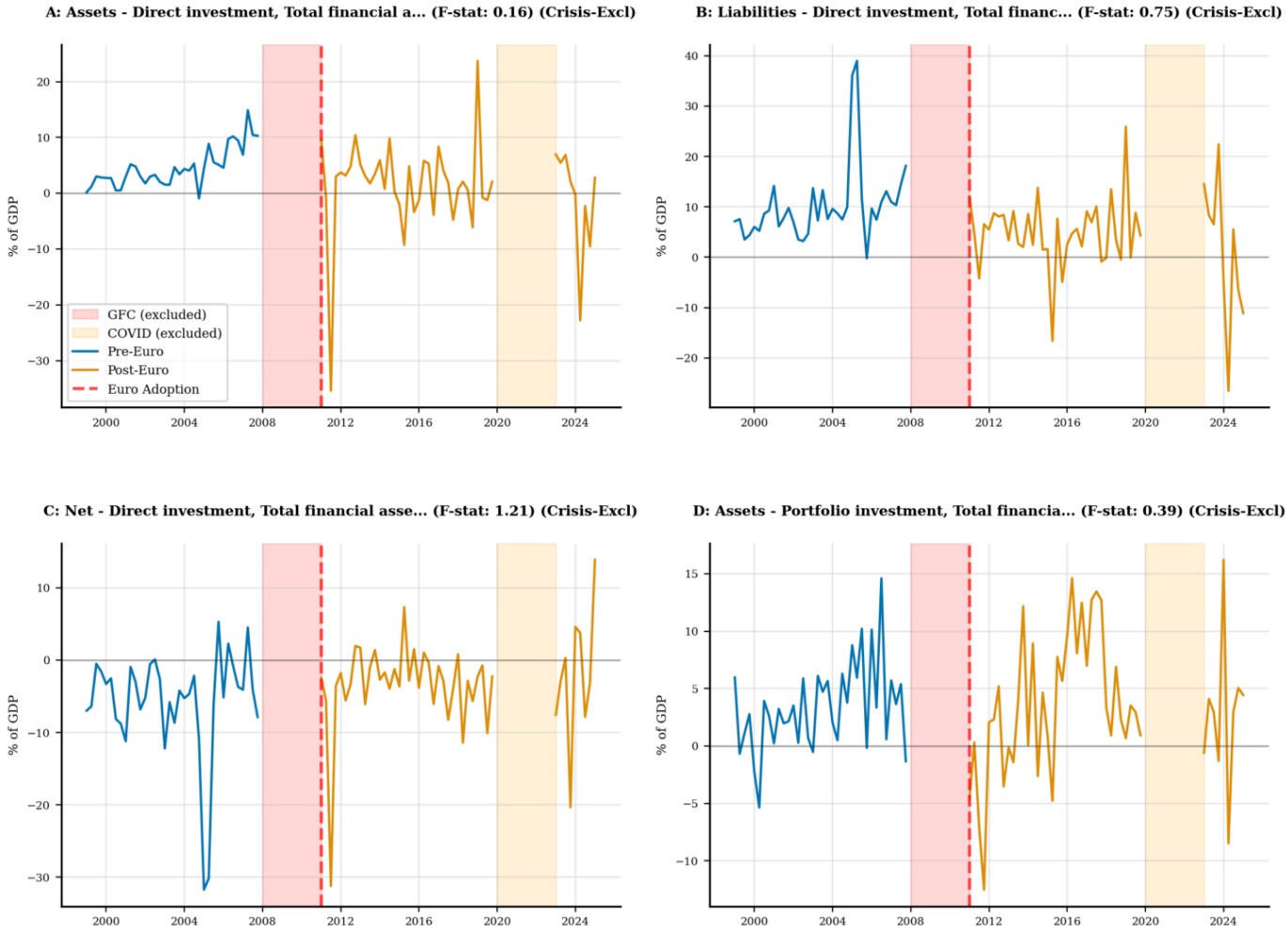
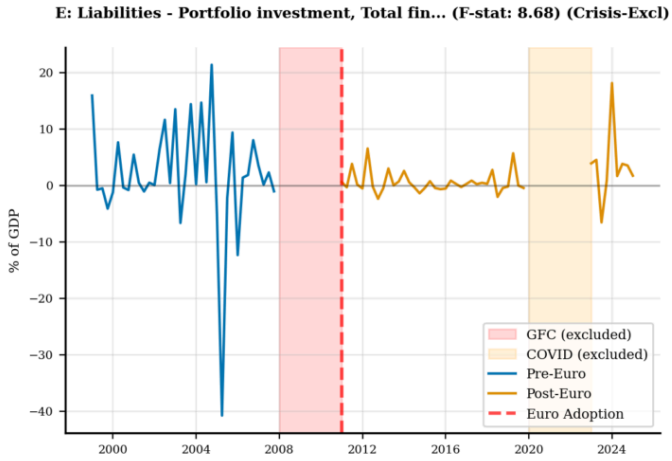
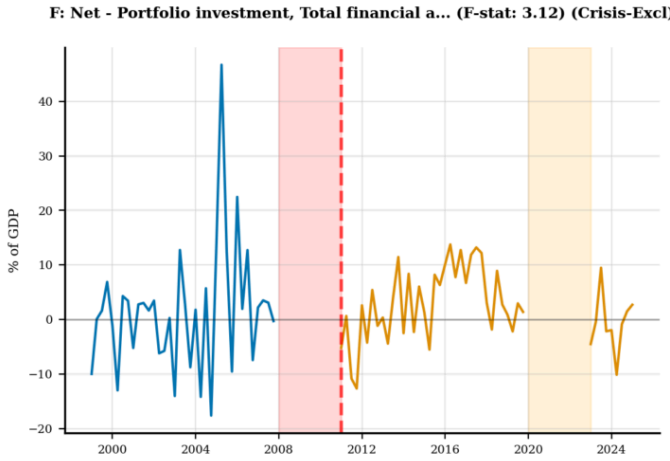
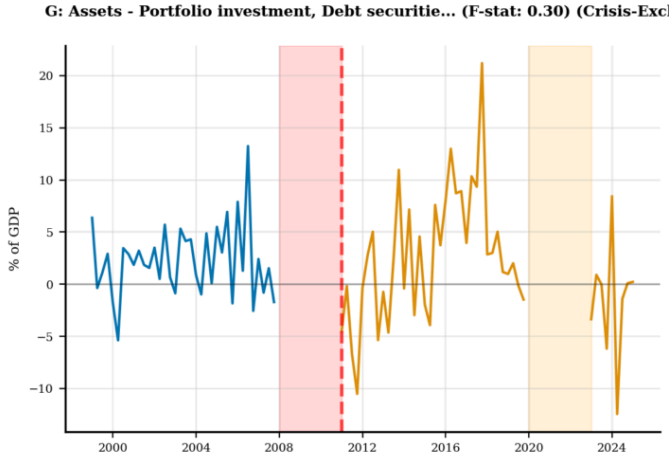
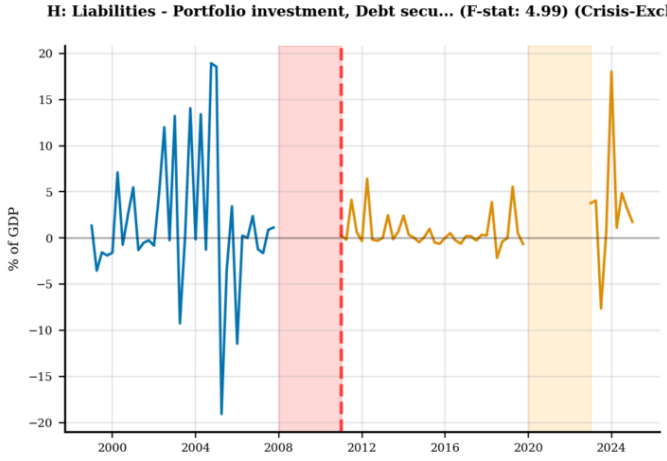
4. Time Series Analysis

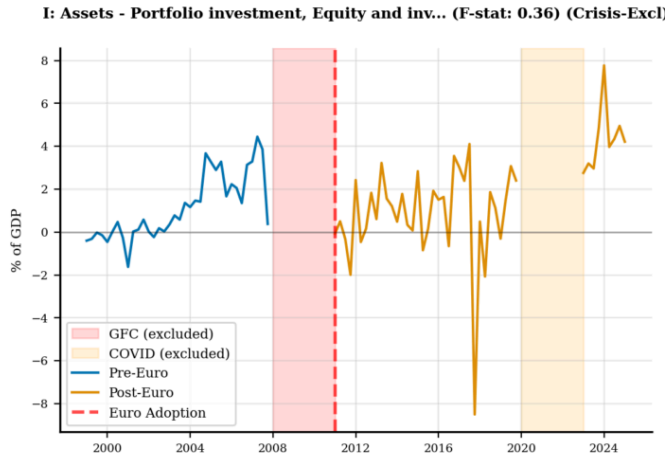

A: Assets - Direct investment, Total financial a... (F-stat: 0.16) (Crisis-Excl)
B: Liabilities - Direct investment, Total financ... (F-stat: 0.75) (Crisis-Excl)
C: Net - Direct investment, Total financial asse... (F-stat: 1.21) (Crisis-Excl)
D: Assets - Portfolio investment, Total financia... (F-stat: 0.39) (Crisis-Excl)
% of GDP
GFC (excluded)
COVID (excluded)
Pre-Euro
Post-Euro
Euro Adoption
2000
2004
2008
2012
2016
2020
2024

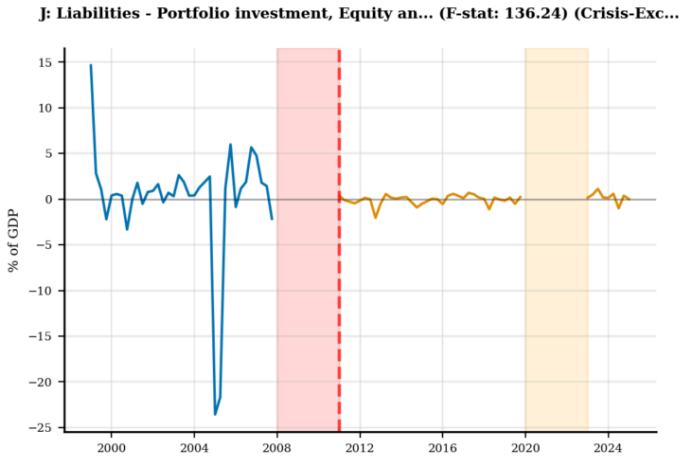

E: Liabilities - Portfolio investment, Total fin... (F-stat: 8.68) (Crisis-Excl)
% of GDP
GFC (excluded)
COVID (excluded)
Pre-Euro
Post-Euro
Euro Adoption

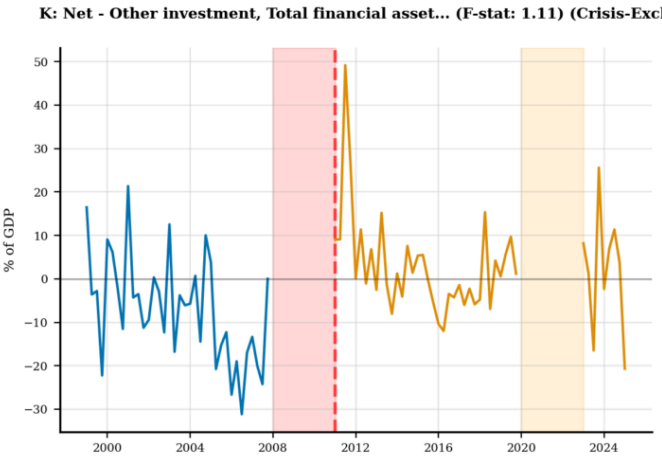

F: Net - Portfolio investment, Total financial a... (F-stat: 3.12) (Crisis-Excl)
% of GDP

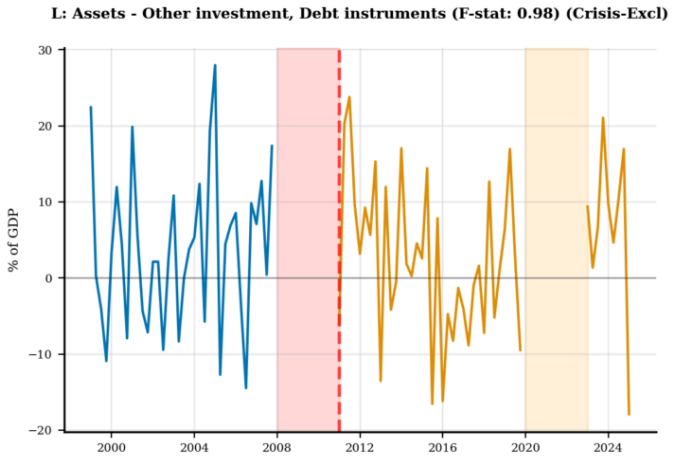

G: Assets - Portfolio investment, Debt securitie... (F-stat: 0.30) (Crisis-Excl)
% of GDP

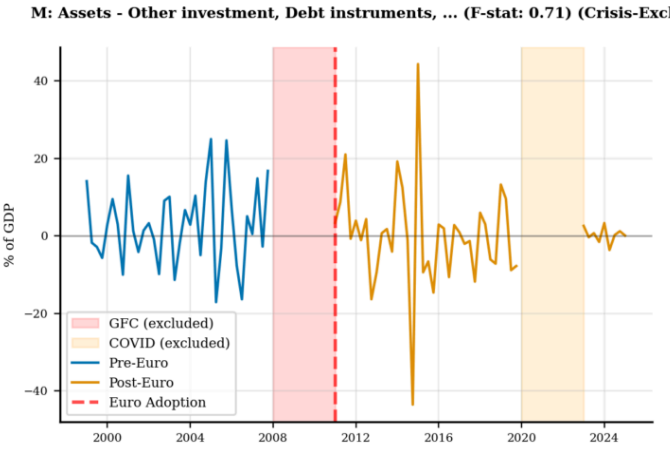

H: Liabilities - Portfolio investment, Debt secu... (F-stat: 4.99) (Crisis-Excl)
% of GDP

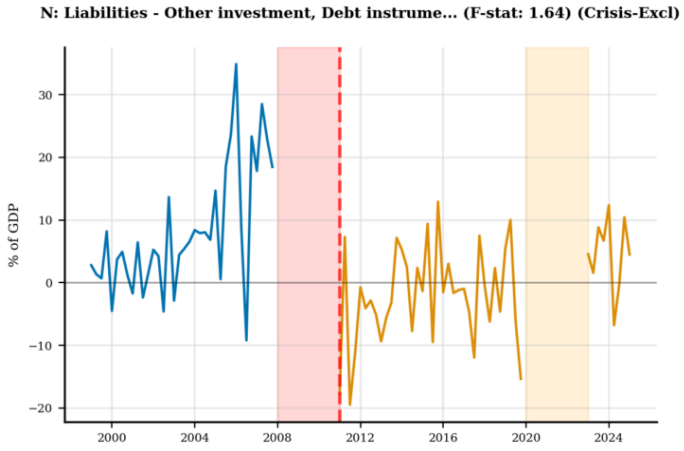












5. Key Findings Summary

Statistical Evidence for Estonia (excluding crisis periods):

Additional Statistical Context:

- **7/14 capital flow indicators** (50.0%) showed higher volatility before Euro adoption
- **8/14 indicators** (57.1%) show statistically significant differences ($p<0.05$)
- **8 indicators** show highly significant differences ($p<0.01$)
- **Average volatility change** of 10.0% after Euro adoption in 2011

Most significant flow types: Liabilities - Portfolio (Equity), Liabilities - Portfolio (Total), Assets - Direct Investment

- **Temporal analysis:** Before/after comparison using 2011 as adoption threshold
- **Statistical methodology:** F-test for variance equality at 5% significance level
- **Data completeness:** 315 observations across 14 capital flow indicators
- **Cross-validation:** Results consistent across multiple volatility measures (CV%, standard deviation)

Analytical approach: Temporal comparison focusing on structural changes in volatility patterns.
