

The cross section of the Great Moderation

Livio Stracca

European Central Bank

Seminar at the Banca d'Italia
14 November 2022

Motivation

- Consensus that the Great Moderation since mid-1980s reflects "better central banking"
- One could see it as a technology that is globally available since the early 1980s (Volcker dis-inflation) after the post-Bretton Woods disorder, and can be adopted more or less freely
- Focus of this work: what countries have performed better in the adoption of this technology and why
- Cross section analysis of 37 advanced economies, 1986-2021
- Cross sectional drivers of the great inflation surge of 2022

Related literature

- Substantial literature documenting the Great Moderation in the United States (e.g. Blanchard and Simon [2001], Gambetti and Gal [2009], Ahmed et al. [2004] and Stock and Watson [2002])
- Most of the literature finds at least some role for good policy, particularly monetary policy, as one of the key determinants (see however Lima et al. [2017] for a more critical view)
- However, the literature on the cross section of the Great Moderation is surprisingly limited
 - Keating and Valcarcel [2012] and Keating and Valcarcel [2017] find that the Great Moderation is not a unique episodes and there were other historical cases of similar compression of volatility, notably post World War II and in the 1920s
 - Summers [2005] and Cecchetti et al. [2006] both documented that the Great Moderation in the mid 1980s was widely experienced, without looking at the drivers of cross country heterogeneity

Preview of the key results

- Inflation levels and volatility and growth volatility since the mid-1980s mostly related to the quality of institutions and selected country characteristics
- Central banking related variables (e.g. central bank independence, exchange rate regime, maybe country size) consistently insignificant
- Therefore, it is not central banking *per se* that matters, but the broader institutional environment
- The cross section of the great resurgence of inflation in 2022 points to a combination of post Covid growth and energy imports from Russia as key drivers

Data

- Annual data for 37 advanced countries, 1970-2021
- Exclude inflation above 100%
- Exclude Covid period for growth

The Great Moderation in inflation

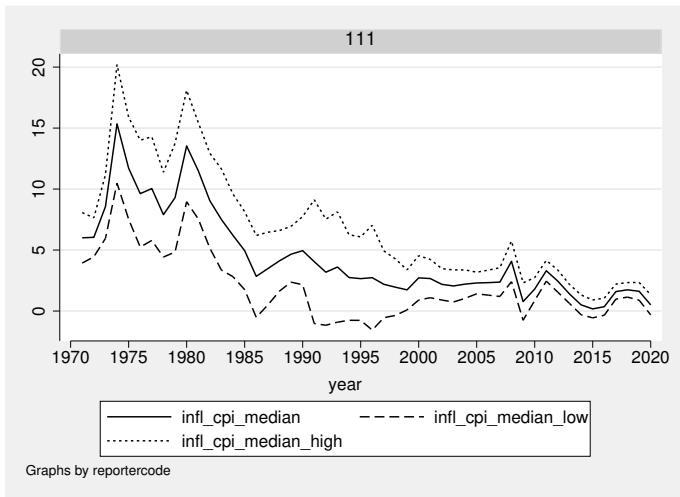


Figure 1: Median inflation in advanced economies and cross country absolute deviation.

Measuring the Great Moderation (for central banks)

- Level and standard deviation of annual CPI inflation, GDP deflator
- Standard deviation of real GDP growth (see e.g. Leveuge and Lucotte [2014])
- Absolute deviation of CPI annual inflation from 2% (only very few countries have inflation targets different from 2%, e.g. Australia (2,5%), Hungary (3%), Iceland (2,5%), Poland (2,5%) and Mexico (3%))
- Robustness: excluding inflation $> 6\%$ (see next slide)

Technology adoption vs intensity

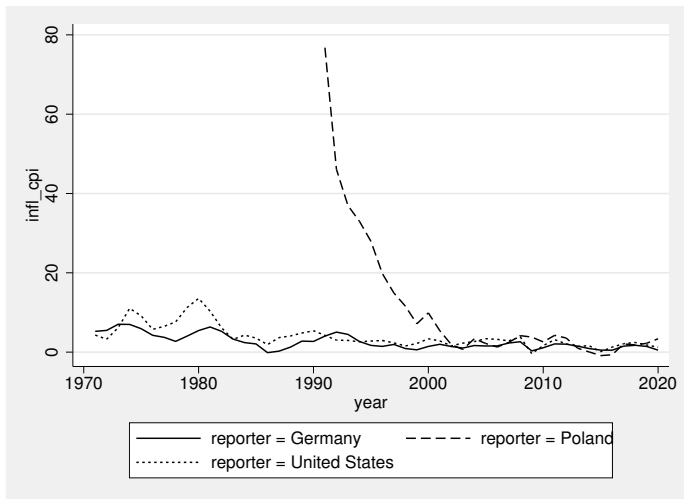


Figure 2: Annual CPI inflation

No trade-off between inflation and growth volatility

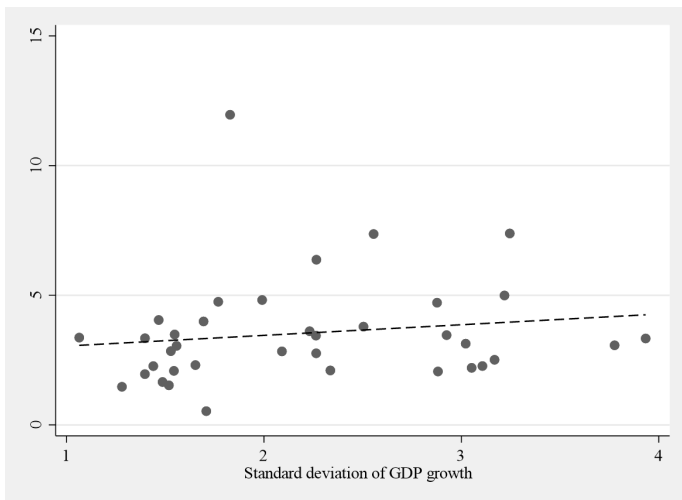


Figure 3: x axis: standard deviation of real GDP growth; y axis: standard deviation of CPI inflation.

Visual illustration that institutions matter

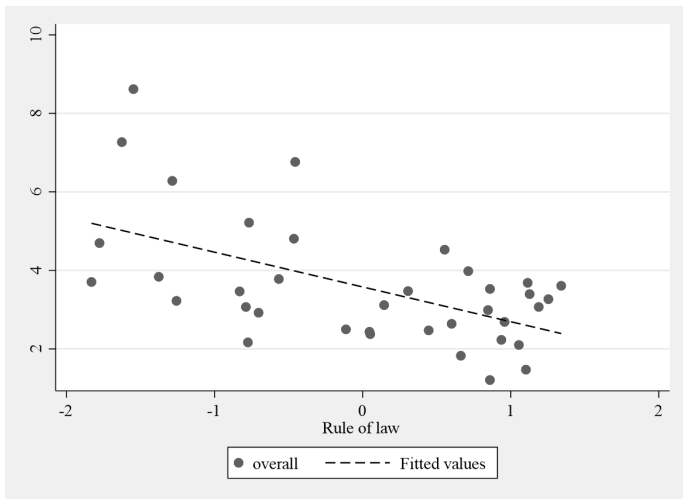


Figure 4: x axis: Rule of Law; y axis: overall central bank loss.

Cross sectional regressions

$$CB_i = \alpha + \beta X_i + \epsilon_i \quad (1)$$

- X is a vector of variables including the potential drivers of central bank performance (all non-dummy elements of the X vector are standardised for ease of interpretation)
- Assume that causality runs from X to CB (more on this later)

Potentially relevant explanatory variables

- Different theories of central bank performance
 - Resources (e.g. for the central bank), or better risk sharing (see Head [1995]) (GDP per capita, population)
 - Quality of institutions (World Bank Rule of Law)
 - Financial development (World Bank)
 - Country structure (weight of manufacturing, oil trade balance)
 - Risk of fiscal dominance (public debt to GDP)
 - Transition economy
 - Central banking specific variables (central bank independence from Garriga [2016], peg vs. float, inflation targeting strategy)

Zoom on inflation targeting

- I will later find that explicit inflation targeting (IT) does not seem to matter much empirically
- Although the theoretical benefits of IT in terms of anchoring inflation expectations are undisputed, the evidence of substantial benefits has proved elusive for advanced countries (see Ball and Sheridan [2004], Lin and Ye [2007], Tawadros [2009])
- Levin et al. [2004]: inflation targeting is often associated to rising, not declining inflation in EMEs (though not in advanced economies); Balima et al. [2017]: positive effects of adopting inflation targeting are at least partly driven by publication bias

Dealing with the dimensionality problem

- Too many regressors with 37 observations - dimensionality problem (Steel [2017])
- Many possible ways to deal with this; here I follow the "best subset regression" approach (Hastie and Friedman [2009])
- How it is implemented: (i) run all possible models containing up to five regressors and only keep models where all included variables are statistically significant at least at the 10 per cent level; (ii) among these models, choose the one with the lowest value of the BIC information criterion
- Robustness: (i) use the Akaike and the adjusted R^2 as alternative information criteria; (ii) consider models up to seven variables

Monte Carlo analysis of this approach

- To check the validity of this approach, I simulate 37 observations from a model with three variables (x_1, x_2, x_3)
- Three additional variables (x_4, x_5, x_6) are simulated that are driven by the first three plus a shock - hence these variables are "nuisance"
- I then the "best subset regression" routine many times over the full set of variables x_1 to x_6 , and find that the right combination of variables is identified $> 99\%$ of the time

What about reverse causality?

- For many of the explanatory variables, concerns about reverse causality are minor, e.g. population
- Higher level argument: monetary neutrality
- For potentially still endogenous variables, instrumental variables
- Caveat: specification search done *before* causality analysis

Baseline OLS results 1986-2021 averages

	(1) Mean inflation (CPI)	(2) Mean inflation (GDP deflator)	(3) Standard deviation inflation (CPI)	(4) Absolute deviation from 2% inflation (CPI)	(5) Mean inflation (CPI) if below 6%	(6) Standard deviation inflation (CPI) if below 6%	(7) Standard deviation inflation (GDP deflator)	(8) Standard deviation real GDP growth	(9) Overall measure
Income per capita (PPP)	-0.67 (0.41)		-0.59* (0.34)		-0.02 (0.12)	-0.47 (0.30)			
Trade openness	-0.42* (0.22)	-0.47** (0.18)			-0.08 (0.06)	-0.31 (0.20)		0.19** (0.08)	
Rule of law	-0.82* (0.41)	-0.92*** (0.28)	-0.85* (0.45)	-1.23*** (0.36)	-0.10 (0.08)	-0.73* (0.37)	-1.03*** (0.32)		-1.02*** (0.30)
Oil imports	0.52** (0.25)		0.48 (0.29)	0.36 (0.23)	0.04 (0.05)	0.35 (0.22)	0.38** (0.16)	-0.20** (0.09)	0.31* (0.16)
Financial development								-0.30** (0.11)	
Observations	37	37	37	37	37	37	37	37	37
R-squared	0.38	0.29	0.33	0.34	0.08	0.35	0.33	0.42	0.34

Robust standard errors in parentheses

Excluding the global financial crisis - similar results

	(1) Mean inflation (CPI)	(2) Mean inflation (GDP deflator)	(3) Standard deviation inflation (CPI)	(4) Absolute deviation from 2% inflation (CPI)	(5) Mean inflation (CPI) if below 6%	(6) Standard deviation inflation (CPI) if below 6%	(7) Standard deviation inflation (GDP deflator)	(8) Standard deviation real GDP growth	(9) Overall measure
Income per capita (PPP)	-0.68 (0.41)		-0.62* (0.36)		-0.02 (0.12)	-0.48 (0.31)			
Trade openness	-0.44* (0.22)	-0.48** (0.19)			-0.08 (0.06)	-0.32 (0.21)		0.19** (0.09)	
Rule of law	-0.81* (0.41)	-0.93*** (0.28)	-0.85* (0.47)	-1.30*** (0.39)	-0.10 (0.08)	-0.73* (0.38)	-1.02*** (0.33)		-1.03*** (0.31)
Oil imports	0.52** (0.25)		0.51* (0.30)	0.41 (0.25)	0.04 (0.05)	0.36 (0.22)	0.37** (0.18)	-0.21** (0.10)	0.32* (0.17)
Financial development								-0.19** (0.09)	
Observations	37	37	37	37	37	37	37	37	37
R-squared	0.38	0.29	0.33	0.33	0.08	0.36	0.31	0.38	0.33

Robust standard errors in parentheses

Results for 1997-2021 - also similar

	(1) Mean inflation (CPI)	(2) Mean inflation (GDP deflator)	(3) Standard deviation inflation (CPI)	(4) Absolute deviation from 2% inflation (CPI)	(5) Mean inflation (CPI) if below 6%	(6) Standard deviation inflation (CPI) if below 6%	(7) Standard deviation inflation (GDP deflator)	(8) Standard deviation real GDP growth	(9) Overall measure
Income per capita (PPP)	-0.35 (0.38)		-0.19 (0.24)		-0.00 (0.09)	-0.22 (0.26)			
Trade openness	-0.29 (0.22)	-0.41** (0.19)			-0.07 (0.07)	-0.24 (0.22)		0.22* (0.11)	
Rule of law	-1.00** (0.42)	-0.92*** (0.28)	-0.88** (0.35)	-0.44*** (0.15)	-0.11 (0.08)	-0.91** (0.37)	-0.93*** (0.23)		-0.83*** (0.20)
Oil imports	0.43* (0.22)		0.34* (0.19)	-0.11 (0.09)	0.04 (0.05)	0.33 (0.21)	0.48*** (0.09)	-0.20** (0.08)	0.22** (0.10)
Financial development								-0.34** (0.13)	
Observations	37	37	37	37	37	37	37	37	37
R-squared	0.33	0.28	0.33	0.37	0.08	0.32	0.37	0.37	0.39

Robust standard errors in parentheses

Robustness: euro area, reverse causality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean CPI inflation 1997-2021 OLS	Mean CPI inflation 1997-2021 OLS Euro area	Mean CPI inflation 1997-2021; Instru- mented: Rule of Law (1996 values)	Mean CPI inflation 2001-2021; Instru- mented: Rule of Law (1996 values)	Standard deviation CPI inflation 1997-2021; Instru- mented: Rule of Law (1996 value)	Standard deviation CPI inflation 2001-2021; Instru- mented: Rule of Law (1996 value)	Standard deviation CPI inflation 1997-2019; Instru- mented: Rule of Law (1996 value)	Standard deviation CPI inflation 2001-2019; Instru- mented: Rule of Law (1996 value)
Income per capita (PPP)	-0.46	-0.91	-0.87	-0.84	-0.70*	-0.68*		
	(0.34)	(0.66)	(0.57)	(0.56)	(0.39)	(0.40)		
Trade openness	-0.23	-0.52	-0.33	-0.30	-0.28	-0.32*		
	(0.23)	(0.68)	(0.20)	(0.20)	(0.19)	(0.19)		
Rule of law	-0.97**	-0.84	-0.28	-0.30	-0.18	-0.28	-0.70***	-0.71***
	(0.43)	(0.56)	(0.49)	(0.50)	(0.37)	(0.39)	(0.17)	(0.18)
Oil imports	0.48**	-3.02	0.34*	0.32	0.20	0.22	0.16*	0.17*
	(0.19)	(2.32)	(0.20)	(0.20)	(0.15)	(0.16)	(0.08)	(0.09)
Euro area first wave	0.90							
	(0.60)							
Observations	37	12	37	37	37	37	37	37
R-squared	0.37	0.69	0.28	0.28	0.28	0.29	0.38	0.37
Endogeneity test			0.0825	0.0864	0.0297	0.0413	0.257	0.281
First stage F			2.118	2.134	2.316	2.220	7.714	7.070

Robust standard errors in parentheses

Interaction with the monetary regime

	(1) Mean inflation (CPI)	(2) Standard deviation inflation (CPI)	(3) Overall performance
Rule of law	-1.32*** (0.39)	-1.31** (0.48)	-1.04*** (0.31)
Trade openness	-0.31 (0.29)	-0.25 (0.28)	-0.15 (0.21)
Trade openness*Peg	-0.07 (0.46)	0.01 (0.47)	-0.09 (0.36)
Oil imports*Peg	1.00** (0.39)	1.00** (0.41)	0.56* (0.30)
Standardized values of (oiltb)	0.22 (0.15)	0.13 (0.16)	0.14 (0.12)
Observations	37	37	37
R-squared	0.38	0.36	0.38

Robust standard errors in parentheses

Summary of the results

- Quality of institutions (Rule of Law) consistently important for Great Moderation performance cross section (exception: when already in the Great Moderation regime) - even in the euro area!
- Trade openness negative for inflation level and volatility, but positively related to growth volatility; financial development reduces growth volatility, but not inflation
- Oil imports have a consistently positive impact on inflation levels and volatility; more so in pegs
- Central banking related variables (e.g. central bank independence, exchange rate regime, maybe country size) consistently insignificant, same for fiscal variables
- Overall message: it is not central banking *per se* that matters, but the institutional environment (and some country characteristics)

Example: central bank independence

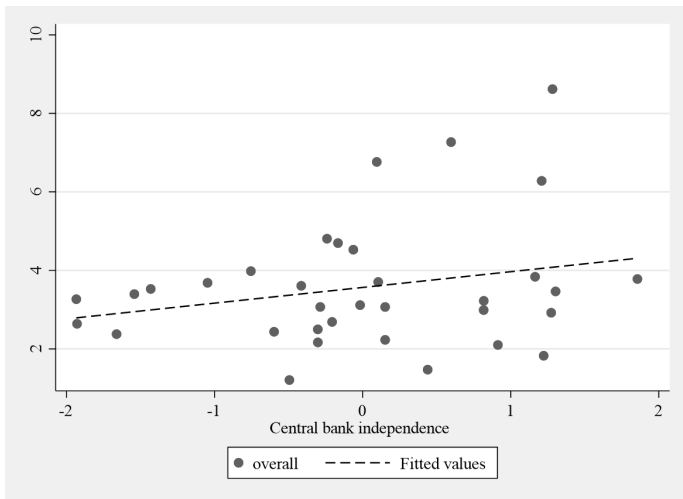
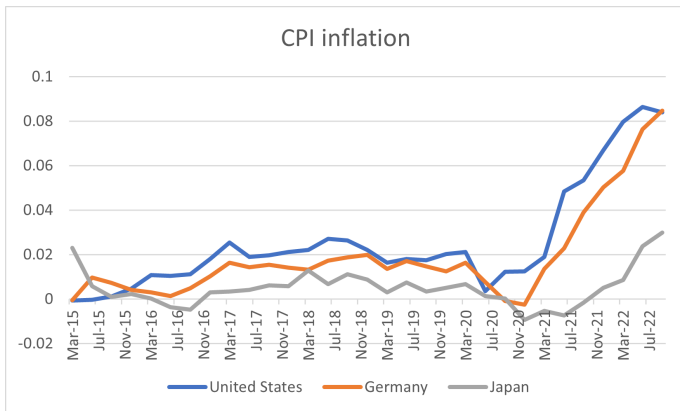


Figure 5: x axis: CBI; y axis: overall central bank performance.

The great inflation surge in 2022



- Is it an interruption or even the end of the Great Moderation?

The cross section of the great inflation surge of 2022

$$\pi_{i,2022} = \alpha + \beta X_{i,2021} + \epsilon_i \quad (2)$$

- $\pi_{i,2022}$ is a measure of the inflation surge
- $X_{i,2021}$ is a vector of pre-2022 variables (not necessarily only in the year 2022)
- Papers doing something similar: Milesi-Ferretti [2021], Lane and Milesi-Ferretti [2011]

Defining the variables

Variable	Definition
Inflation surprise in 2022	Deviation of 2022 CPI headline and core inflation from 2015-2021 average
Past inflation trend	CPI headline inflation average in 2015-2021 and 2015-2019
Economic growth during Covid	Real GDP growth in 2020 and in 2021
Stance of fiscal policy	Cyclically adjusted primary balance/GDP in 2021; source: IMF
Stance of monetary policy	2-year interest rate minus core inflation average 2021
Oil imports and imports from Russia	IMF data (WEO and Direction of Trade) for 2021
Quality of institutions	Rule of Law and emerging market dummy

Table 1: Cross sectional data, 55 countries.

Results for the 2022 surge

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Headline	Headline	Headline	Headline	Core	Core	Core	Core
Oil imports 2021	0.20 (0.14)	0.15 (0.19)			0.41* (0.20)	0.09 (0.24)		
Imports from Russia 2021	0.47*** (0.16)	0.48** (0.21)	0.44*** (0.09)	-0.26 (0.23)	-0.05 (0.17)	0.08 (0.21)	0.13* (0.07)	-0.08 (0.20)
Growth 2020	-0.02 (0.14)	0.26 (0.17)			-0.04 (0.12)	0.10 (0.15)		
Growth 2021	0.09 (0.14)	0.34* (0.17)	0.18* (0.10)	0.02 (0.17)	0.27** (0.13)	0.23 (0.17)	0.27*** (0.08)	0.28* (0.16)
Inflation 2015-2019	-4.72*** (0.97)	0.18 (0.17)	-4.36*** (0.76)	-3.67*** (0.74)	-4.47** (1.64)	1.78*** (0.30)	-2.87** (1.27)	-3.09** (1.34)
Inflation 2015-2021	5.14*** (1.00)		4.74*** (0.78)	3.97*** (0.76)	5.55*** (1.44)		4.03*** (1.07)	4.12*** (1.11)
Cyclically adjusted primary balance 2021	-0.07 (0.12)	-0.09 (0.16)			-0.00 (0.09)	-0.02 (0.11)		
Trade openness 2021	-0.16 (0.15)	-0.21 (0.20)	-0.03 (0.09)	0.00 (0.29)	-0.38* (0.22)	-0.09 (0.27)	-0.05 (0.09)	0.09 (0.25)
Rule of Law 2020	0.03 (0.21)	-0.24 (0.27)			0.13 (0.16)	-0.19 (0.18)		
EME dummy	-0.25 (0.20)	-0.28 (0.27)	-0.23* (0.12)	-0.16 (0.11)	-0.70*** (0.21)	-1.01*** (0.26)	-0.71*** (0.17)	-0.65*** (0.20)
Growth 2021*Imports from Russia 2021				0.01*** (0.00)				0.00 (0.00)
Growth 2021*Trade openness 2021				-0.00 (0.05)				-0.02 (0.04)
Countries	42	42	50	50	30	30	38	38
R-squared	0.70	0.45	0.67	0.74	0.91	0.84	0.86	0.87

Results for the 2022 surge

- (Energy) imports from Russia key for headline inflation
- Rising inflation in 2020-2021 a strong predictor for both core and headline
- 2021 growth important, in particular for core; interaction with Russia imports significant for
- Overall message: energy shock from Russia important; however inflation trend and growth in the post Covid period relevant as well
- Fiscal policy, trade openness (bottlenecks), institutions all insignificant (but yet to be looked at: fiscal dominance, FX regime)

Key results again

- Inflation levels and volatility and growth volatility since the mid-1980s mostly related to the quality of institutions and selected country characteristics
- Central banking related variables (e.g. central bank independence, exchange rate regime, maybe country size) consistently insignificant
- Therefore, it is not central banking *per se* that matters, but the broader institutional environment
- The cross section of the great resurgence of inflation in 2022 points to a combination of post Covid growth and energy imports from Russia as key drivers

- S. Ahmed, A. Levin, and B. A. Wilson. Recent U.S. Macroeconomic Stability: Good Policies, Good Practices, or Good Luck? *The Review of Economics and Statistics*, 86(3): 824–832, August 2004. URL <https://ideas.repec.org/a/tppr/restat/v86y2004i3p824-832.html>.
- H. W. Balima, E. G. Kilama, and R. Tapsoba. Settling the Inflation Targeting Debate: Lights from a Meta-Regression Analysis. IMF Working Papers 17/213, International Monetary Fund, Sept. 2017. URL <https://ideas.repec.org/p/imf/imfwpa/17-213.html>.
- L. M. Ball and N. Sheridan. Does Inflation Targeting Matter? In *The Inflation-Targeting Debate*, NBER Chapters, pages 249–282. National Bureau of Economic Research, Inc, June 2004. URL <https://ideas.repec.org/h/nbr/nberch/9561.html>.
- O. Blanchard and J. Simon. The Long and Large Decline in U.S. Output Volatility. *Brookings Papers on Economic Activity*, 32 (1):135–174, 2001. URL <https://ideas.repec.org/a/bin/bpeajo/v32y2001i2001-1p135-174.html>.

- S. G. Cecchetti, A. Flores-Lagunes, and S. Krause. Assessing the Sources of Changes in the Volatility of Real Growth. NBER Working Papers 11946, National Bureau of Economic Research, Inc, Jan. 2006. URL <https://ideas.repec.org/p/nbr/nberwo/11946.html>.
- L. Gambetti and J. Gal. On the sources of the great moderation. *American Economic Journal: Macroeconomics*, 1(1):26–57, 2009. URL <https://EconPapers.repec.org/RePEc:aea:aejmac:v:1:y:2009:i:1:p:26-57>.
- A. C. Garriga. Central Bank Independence in the World: A New Data Set. *International Interactions*, 42(5):849–868, October 2016. doi: 10.1080/03050629.2016.116. URL <https://ideas.repec.org/a/taf/ginixx/v42y2016i5p849-868.html>.
- T. R. Hastie, T. and J. Friedman. *The elements of statistical learning*. New York: Springer, 2009.
- A. Head. Country size, aggregate fluctuations, and international risk sharing. *Canadian Journal of Economics*, 28(4b):1096–1119,

1995. URL <https://EconPapers.repec.org/RePEc:cje:issued:v:28:y:1995:i:4b:p:1096-1119>.
- J. Keating and V. V. Valcarcel. Greater moderations. *Economics Letters*, 115(2):168–171, 2012. URL <https://EconPapers.repec.org/RePEc:eee:ecolet:v:115:y:2012:i:2:p:168-171>.
- J. W. Keating and V. J. Valcarcel. What's so great about the Great Moderation? *Journal of Macroeconomics*, 51(C):115–142, 2017. doi: 10.1016/j.jmacro.2017.01. URL <https://ideas.repec.org/a/eee/jmacro/v51y2017icp115-142.html>.
- P. Lane and G. M. Milesi-Ferretti. The cross-country incidence of the global crisis. *IMF Economic Review*, 59(1):77–110, 2011. URL <https://EconPapers.repec.org/RePEc:pal:imfecr:v:59:y:2011:i:1:p:77-110>.
- G. Leveuge and Y. Lucotte. A Simple Empirical Measure of Central Banks' Conservatism. *Southern Economic Journal*, 81(2):409–434, October 2014. URL <https://ideas.repec.org/a/sej/ancoec/v812y2014p409-434.html>.

- A. T. Levin, F. M. Natalucci, and J. M. Piger. The macroeconomic effects of inflation targeting. *Review*, 86(Jul): 51–80, 2004. URL <https://ideas.repec.org/a/fip/fedlrv/y2004ijulp51-80nv.86no.4.html>.
- G. T. Lima, M. Setterfield, and J. J. da Silveira. The Great Deception: the science of monetary policy and the Great Moderation revisited. Working Papers 1729, New School for Social Research, Department of Economics, Oct. 2017. URL <https://ideas.repec.org/p/new/wpaper/1729.html>.
- S. Lin and H. Ye. Does inflation targeting really make a difference? Evaluating the treatment effect of inflation targeting in seven industrial countries. *Journal of Monetary Economics*, 54(8): 2521–2533, November 2007. URL <https://ideas.repec.org/a/eee/moneco/v54y2007i8p2521-2533.html>.
- G. M. Milesi-Ferretti. The Travel Shock. CEPR Discussion Papers 16738, C.E.P.R. Discussion Papers, Nov. 2021. URL <https://ideas.repec.org/p/cpr/ceprdp/16738.html>.

- M. F. J. Steel. Model Averaging and its Use in Economics. MPRA Paper 90110, University Library of Munich, Germany, Sept. 2017. URL <https://ideas.repec.org/p/pramprapa/90110.html>.
- J. Stock and M. Watson. Has the business cycle changed and why? NBER Working Papers 9127, National Bureau of Economic Research, Inc, 2002. URL <https://EconPapers.repec.org/RePEc:nbr:nberwo:9127>.
- P. M. Summers. What caused the Great Moderation? : some cross-country evidence. *Economic Review*, (Q III):5–32, 2005. URL <https://ideas.repec.org/a/fip/fedker/y2005iqiip5-32nv.90no.3.html>.
- G. B. Tawadros. Testing the impact of inflation targeting on inflation. *Journal of Economic Studies*, 36(4):326–342, September 2009. URL <https://ideas.repec.org/a/eme/jespps/v36y2009i4p326-342.html>.