News Shocks and Sudden Stops *

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Abstract

I examine the role of news shocks in causing Sudden Stops in emerging market economies. In a small open production economy with capital accumulation, a collateral constraint on borrowing creates a pecuniary externality that leads to overinvestment in good times and a Sudden Stop in some states. I introduce news shocks as signals about future TFP into this framework. I calibrate the model to data from Mexico, using text-based analysis of media articles and time-series analysis to identify news shocks. I show that news shocks increase the unconditional Sudden Stop probability from 4.5% to 5.3%. Without the corrective policy, news shocks can decrease welfare even though they provide additional, useful information. Incorrect positive news, where tomorrow's high productivity is unrealized, increases future binding constraint likelihood. News shocks require more active policy intervention to correct the externality, with a larger tax on borrowing in good times and greater subsidy during crises.

JEL Codes: E22, E32, F41

Keywords: TFP News Shocks, Open Economy Macroeconomics, Sudden Stops, Optimal Policy, Natural Language Processing

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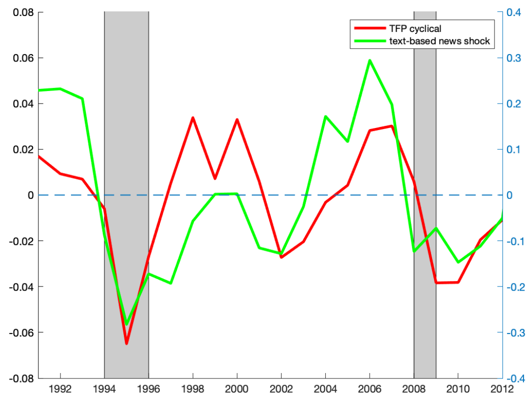
1 Introduction

Before the 1994 Mexican Peso Crisis and the 2008 Global Financial Crisis, positive news about the six-year higher GDP growth development plan and further tariff removal under the North American Free Trade Agreement (NAFTA) signaled higher future productivity. This positive news, which persisted for long periods, led to an accumulation of borrowing and investment by the Mexican economy. However, when reality fell short of the over-positive outlook, it resulted in Sudden Stops and severe economic decline. Analyzing the context of Mexico in 1994, the failure of high productivity to materialize could be ascribed to political and social turmoil, which also pointed to low future productivity. This outcome can be linked to several pivotal events: the turbulence arising from the Zapatista civil conflict and the assassination of the presidential candidate and the secretary general. In this paper, I construct data on news shocks[1] and observe a positive correlation between news shocks and future Total Factor Productivity (TFP) that decreases around Sudden Stop episodes. As shown in Figure 1, positive news in the years before the 1994 Sudden Stop episode, a crisis identified based on a substantial increase in the current account, is followed by low productivity realization at the start of the crisis. Across the years, there is a positive correlation between news shocks and TFP one year later; however, this correlation is less strong during years around the Sudden Stop episodes. Hence, this paper explores what policymakers should do in response to prolonged TFP news shocks. It examines how these shocks influence susceptibility to Sudden Stops and analyzes the corresponding variations in policy implementation. This paper shows that news shocks increase the frequency of Sudden Stops and call for an active policy stance.

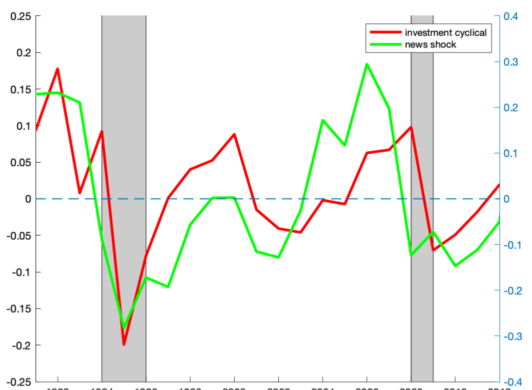
To provide further context, Figure 1 showcases the relationship between a measure of news shock, TFP, investment per capita, and the current account to GDP ratio. The news shock measure in the figure is derived following a similar methodology as outlined in the works of Buckman et al. (2020) and Shapiro, Sudhof, and Wilson (2017) but performed on Mexican news articles reporting news about the economy and future productivity. Before each Sudden Stop episode, the economy experiences positive news about future productivity, which drives increased investment and capital inflows, as seen in the regions preceding the grey bands in Figure 1. However, this positive news

[1] News shock is a signal that provides information about future productivity, as mentioned in Beaudry and Portier (2014) and Kurmann and Sims (2021). Further details on how the news shocks are identified are provided in section 2.

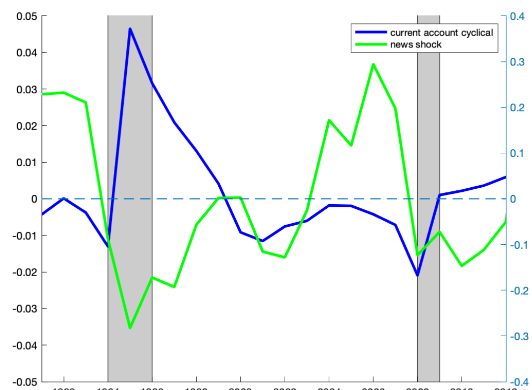
tends to be subsequently followed by Sudden Stop episodes where the current account reverses, and investment declines significantly. The negative news that follow exacerbates the investment drop and the current account reversal during the initial phase of Sudden Stop episodes. Therefore, investigating the impact of positive or negative news shocks on the economy during different economic conditions becomes an intriguing area of interest.



(a) News Shock and TFP Cyclical component



(b) Mexico Investment Cyclical component



(c) Mexico Current Account Cyclical component

Figure 1: Cyclical TFP (red, (a)), cyclical real Investment per capita in local currency units (red, (b)) and Current Account to GDP ratio (blue, (c)) with respect to news shocks (green) basing on the text based analysis developed by Buckman et al. (2020) and Shapiro, Sudhof, and Wilson (2017) on newspaper articles regarding the Mexican economy. The right y axes corresponds to units for news shocks while the left axes corresponds to units for the other variables. The first grey band (Mexican Peso Crisis Sudden Stop episode from 1994-1996) and the second grey band (Global Financial Crisis Sudden Stop episode from 2008-2009) were identified by Benigno et al. (2020).

To investigate the questions of interest, I analyze a small open production economy model with capital accumulation, where the representative agent encounters a collateral constraint that incorporates the price of capital. This feature engenders a pecuniary externality, rendering the economy susceptible to Sudden Stops, characterized by an occasionally binding collateral constraint. The private agent does not internalize the pecuniary externality as the agent undervalues the social marginal cost of borrowing. When a negative TFP shock causes the collateral constraint to bind, it causes a Fisherian debt-deflation amplification mechanism such that the private agent fire-sale capital that serves as collateral, in turn, drives down the price of capital and then tightening the constraint further and forces further fire sales. Furthermore, I contribute to the literature on Sudden Stops with a model that explicitly incorporates news shocks, which provide information on future TFP and depend on the previous period's news shock, thereby enabling a more persistent mechanism of news shocks that underlie borrowing and investment decisions within the production framework. Building upon established models in the Sudden Stops literature, including Mendoza (2010), Bianchi (2011), Bianchi, Liu, and Mendoza (2016), this paper introduces a production framework with capital accumulation, allowing for differentiation in the planner's role during normal and adverse times. This facilitates the exploration of macroprudential and ex-post policy considerations, as previous models are developed such that the planner cannot improve upon the competitive equilibrium allocation when the constraint is binding. Additionally, this paper examines various constraint specifications and assesses the impact of an unconventional news shock. By incorporating news shocks, the agent receives information about TFP in the subsequent period. A positive news shock today suggests a higher TFP in the future, potentially leading to increased future income. This positive news shock incentivizes the agent to elevate capital investment. However, as future income has yet to be realized, the agent resorts to greater borrowing to finance capital investment, heightening the economy's vulnerability to future adverse shocks if the anticipated high TFP fails to materialize.

Before numerically solving for the impact of news shocks, this paper first identifies news shocks through news articles. Using a news aggregator service, I examine Mexican news articles from 1991 to 2013, focusing on economic articles about future productivity. I employ an economic news lexicon on the collated articles to assign a score to each article and construct a yearly index of news shocks. Given the challenges of amassing news articles across numerous countries, I proceed with another empirical methodology that extracts TFP news component after regressing TFP on forecast error data, expanding the news shocks data to 21 emerging and developing economies.

For these countries analyzed, the news shocks entail a TFP anticipation horizon of one year.

With data on news shocks, I discipline the news shock parameters in the model with the correlation between news and future TFP realization. In addition to incorporating news shocks, the calibration process uses data from Mexico, an emerging economy that has experienced Sudden Stop events. The collateral constraint and discount factor were calibrated to the investment-to-GDP ratio and the observed frequency of Sudden Stops. The model exhibits procyclical consumption, investment, and a counter-cyclical current account like the Mexican data moments. Furthermore, introducing news shocks in the model enhances the match for volatility, correlation, and autocorrelation moments. The rationale behind this improved match is that news shocks lead to greater borrowing and capital investment fluctuations. The heightened volatility in these variables allows for a better alignment with the observed higher volatility and reduced cyclicality in relation to GDP. Therefore, with empirical counterpart results, I introduce news shocks into the model with collateral constraint for the primary inspection of quantifying its effect in terms of Sudden Stops.

In terms of the findings, three main results emerge. Firstly, news shocks contribute to higher frequency of Sudden Stops. Even when considering a future value constraint specification proposed by Ottonello, Perez, and Varraso (2022), news shocks still elevate the likelihood of Sudden Stops. Their finding shows that a future value constraint specification differs in that it exhibits no borrowing inefficiency. While their finding holds in this setting, quantitative analysis reveals that news shocks increase the frequency of Sudden Stops for either collateral constraint specification by around 0.8 percentage points. Secondly, impulse response functions show that asymmetries exist when comparing incorrect positive and negative news shocks. A negative news causes a Sudden Stop episode today, while an incorrect positive news shock where the next period's high TFP is not realized causes future Sudden Stops and is the primary contributor of Sudden Stops and distortions to borrowing and investment in an economy subject to news shocks. Intriguingly, positive news over negative news shock in adverse times can expedite recovery back to the steady state. Thirdly, the planner's allocation deviates from the competitive equilibrium when the constraint is binding and not binding. Unlike private agents, the planner internalizes the pecuniary externality, leading to reduced capital investment and even more diminished borrowing to lower the probability and severity of a crisis. Conversely, when the constraint binds, the planner strategically increases capital investment, recognizing the social benefits of holding on to more capital that will mitigate the tightening of the constraint compared to the competitive equilibrium. The optimal policy that decentralizes the planner's allocation involves taxing capital or debt when the constraint is non-binding and subsidizing capital or debt when the constraint binds. The policy is asymmetric in the presence of news shocks as it is based on the economy's state and news shock received. Averaging across the shocks, a substantial policy rate is proposed.

Related Literature.—This paper is related to a group of key papers in the literature on Sudden Stops, financial stability, and macroprudential policy. Mendoza (2002, 2010), Bianchi (2011), Bianchi, Liu, and Mendoza (2016), Bianchi and Mendoza (2020), Mendoza and Villalvazo (2020) are key papers in the literature that details the Sudden Stops phenomenon arising from an occasionally binding constraint. In a similar setting, Schmitt-Grohé and Uribe (2021) details about the issue of multiplicity. Bianchi (2011), and Bianchi and Mendoza (2010, 2020) study how an overborrowing phenomenon makes the economy susceptible to a Sudden Stops and explain that macroprudential policy can provide welfare gains. Additionally, Bianchi and Mendoza (2018) detail the issue of time consistency in such a policy. Separately, Benigno et al. (2013, 2016) look into exchange rate policy implementation and detail a two-sector production model where the economy features underborrowing. Ottonello, Perez, and Varraso (2022) explain that macroprudential policy's effectiveness depends on the borrowing constraint's specification. Bianchi and Mendoza (2018) study a current value collateral constraint while Lian and Ma (2021) and Céspedes, Chang, and Velasco (2022) study a future value collateral constraint. In an interesting twist, Akıncı and Chahrour (2018) mention that news shock help match empirical facts about Sudden Stops related to current account and Bianchi, Liu, and Mendoza (2016) mention how a tax on debt can reduce inefficiencies caused by the news shock. For this paper, it differs in several dimensions: first, it investigates the incorporation of persistent news shocks that can become incorrect and are matched to data; second, it examines the asymmetric effects of ex-ante and ex-post policies in a production setting with capital accumulation; and third, I consider different borrowing constraints.

Another piece of literature related to this paper is theoretical papers that cover and analyze news shocks. First proposed by Pigou (1927), he mentions that news shock could be an important driver of business cycle fluctuations. More recently, theoretical contributions of Beaudry and Portier (2004) explain that these news shocks can generate recession and business cycle patterns. In addition, Jaimovich and Rebelo (2009) incorporate elements of variable capital utilization, adjustment costs to investment, and preferences eliminating wealth effects into their model, showing that news shock can match periods of expansion and recession in the data. They also show similar results in a small open economy model version, Jaimovich and Rebelo (2008). Schmitt-Grohé and Uribe (2012) explain that anticipated news shocks cause one-half variances of output, hours, consumption, and investment. On the other hand, Christiano et al. (2008) include sticky wages and a Taylor-rule based monetary policy to their model to generate a boom-bust cycle. In a related theme, Chang and Fernández (2013) and Aguiar and Gopinath (2007) study whether persistence in productivity shocks generates fluctuations in emerging economies. This paper aims to incorporate the feature of an occasionally binding constraint from the Sudden Stops literature to analyze persistent news shocks in a setting with Sudden Stops.

Lastly, in line with the theoretical literature on news Shock, there are numerous papers providing empirical support. For one, Cascaldi-Garcia (2022) uses forecast revisions from the Survey of Professional Forecasters as an instrument to identify news shocks in a sVAR and find that news shocks are important in explaining business cycles. Anzoategui (2022) also finds that news shocks are important in explaining the boom and bust cycles in the data. Also, Beaudry and Portier (2006, 2014) explain that these news shocks generate positive co-movements for GDP, consumption, and hours worked and concluded that news shock explains more than 50% of GDP fluctuations in the US. However, empirical papers such as Barsky and Sims (2011) using an sVAR with other variables, and an alternative identification strategy find contradicting results. Specifically, Barsky and Sims (2011) shows that a positive news shock increases consumption and GDP but decreases investment and hours worked. In line with that, Miyamoto and Nguyen (2020) finds a modest role in news shocks regarding business cycles. Hence, the literature seeks to examine further the importance of news shock in explaining business cycles. In this paper, I empirically show that a positive TFP news shock, unlike in Barsky and Sims (2011), increases investment and that a text-based identified news shock measure co-move with the time series empirical approach proposed in this literature.

Layout.−Section 2 presents the two empirical methodologies performed to identify news shocks and discusses the empirical evidence that supports the main implications of the model. Section 3 presents the model and performs the quantitative analysis. Section 4 concludes.

2 News Shocks

This section details the computational text-based analysis and empirical approaches adopted to identify news shocks and the corresponding empirical results. Further data set details are described in Appendix A. In the first approach, I collate media news articles reflecting information about future productivity in Mexico. After processing these articles using an economic news lexicon that assigns scores to each article, I then construct a yearly index for news shocks. To extend the analysis to 21 emerging and developing economies, I perform a second approach that extracts news shock components from regressing TFP growth on forecast errors.

2.1 Text-Based Analysis - A Natural Language Processing Approach

Regarding data for the computational text analysis, I use the news aggregator service Factiva through an academic account that provides an extensive digital historical collections of global news sources. The analysis begins with examining a dataset comprising news articles from Mexico from 1991 to 2013. To ensure the reliability and relevance of the selected articles, I employ specific criteria during the collation process. Firstly, the articles must pertain to the region of Mexico. Secondly, the subject matter should revolve around economic news. Additionally, each article is required to contain a minimum of 200 words, and the presence of essential keywords such as "Economy," "Economic," and "Mexico" is crucial for their inclusion. To zone in on news articles that reflect information about future productivity changes, article need to contain word(s) that relate to changes in R&D efficiency. Moreover, I take precautions to remove duplicate articles that are either identical or highly similar in content, thus avoiding redundancy. The application of these criteria ensures that the focus remains on Mexico's economic news while minimizing any potential noise caused by very short articles.

With the collated news article dataset, I proceed with the economic news lexicon developed by Buckman et al. (2020) and Shapiro, Sudhof, and Wilson (2017). Their methodology involves three main steps. Firstly, each sentence in the data set of economic news articles is assigned a class (positive, neutral, negative). This is done by using the modified Vader sentence classifier and also incorporating the Loughran and McDonald (2011) and Hu and Liu (2004) lexicons, which are words with associated positive or negative scores. Performing this step provides a measure of orientation for each sentence. Secondly, a word-by-class matrix is created to count the co-occurrence of words with each class. Finally, the degree of association between each word and positive, negative, or neutral sentences is calculated using pointwise mutual information (PMI), which measures the confidence of a word's association with a specific class. The score for each word is determined by the difference between PMI values for positive and negative classes. The scores are normalized to a range of -1 to 1. Examples of positive words are "increase," "innovate," and "invent," while examples of negative words are "decline," "regressive," and "limit." By employing this rigorous method and leveraging it on the Mexican news articles of interest it provides a time series index of economic news shock, facilitating a nuanced understanding of the evolving economic landscape in Mexico as seen in Figure 1. When the data set is separated only to contain Spanish or English articles, the patterns underlying the news shocks remain similar.[2]

2.2 Empirical Approach

I now use the method developed by Anzoategui (2022) to identify news shocks from TFP data and apply it to a set of 21 emerging and developing economies.

The methodology assumes that Total Factor Productivity (TFP) follows a random walk, where $\Delta a_t = log(A_t) - log(A_{t-1})$. Here, TFP growth, Δa_t, is affected by a surprise TFP shock and an anticipated news shock. By regressing TFP growth on the forecast errors, U_t, the residual of the regression, is the anticipated component of TFP growth. As the analysis is based on a large sample of economies, I mainly focus on three forecast series for each economy: real GDP growth, CPI inflation rate, and the current account to GDP ratio. In the subsequent regression analysis, the derived news shocks, represented as $\sigma_a \varepsilon^a_{t,t-k}$, are obtained by deducting the TFP growth from the product of the regression coefficient Π and the associated forecast errors. The expression $\sigma_a \varepsilon^a_{t,t-k}$ where $\sigma_a > 0$ and $\varepsilon^a \sim N(0,1)$, is such that news is known at time t-k which means that $\mathbb{E}_t[\varepsilon^a_{t,t-k}] = \varepsilon^a_{t,t-k}$.

[2]Appendix B documents several findings. First, it shows that this text-based measure of news shocks yields similar results when articles are solely in Spanish or English, especially with respect to domestic and foreign investment. Second, it demonstrates that the level of uncertainty in news shocks rose before the 1994 Mexican Sudden Stop episode. Finally, it indicates that actual TFP shocks correspond to fluctuations in both investment and the current account during the same period.

$$\Delta a_t = \Pi U_t + \sigma_a \varepsilon^a_{t,t-k}$$

The forecast error at time t is given by $U_t = Y_t - \mathbb{E}_{t-1}(Y_t) = \Theta_0 \varepsilon_t$ such that ε_t represents the vector of current structural shocks that includes the surprise TFP shocks and the news shock received at time t but affecting TFP growth k periods after, $\varepsilon^a_{t+k,t}$. Also, Θ_0 is a $n_y \times n_\varepsilon$ matrix of coefficients that relates the current values of the n_y macroeconomic variables to the current values of the n_ε structural shocks. Then, to properly scrutinize the impact of news shocks over the sample of economies analyzed, it is crucial to determine the anticipation horizon, which is the value of k. Hence, to establish a valid anticipation horizon, I perform a regression on a forward-looking variable such as investment to infer a relevant anticipation horizon as shown in Table 1.[3]

Proceeding with my analysis, I adopt a similar empirical methodology employed by Arezki, Ramey, and Sheng (2017), which captures the dynamic impact of news shocks quantified through the impulse response functions. In the expression below, I employ their dynamic panel model with a distributed lead of news shock, as outlined below.

$$Y_{i,t} = \rho Y_{i,t-1} + \beta_0 \sigma_a \varepsilon^a_{i,t,t-1} + \sum_{k=1}^{K} \beta_k \sigma_a \varepsilon^a_{i,t+k,t} + \alpha_i + \mu_t + Controls + \nu_{i,t} \tag{1}$$

where $Y_{i,t}$ is either the current account to GDP ratio or the log difference of investment, where each of them was linearly detrended to obtain the cyclical component. On the right-hand side, there is one lag for $Y_{i,t}$. Also, the news shock, $\varepsilon^a_{i,t+k,t}$, is associated with β_k that represents the regression coefficient associated with different possible total leads K of the news shocks, where $k = 0, 1, ..., K$. Accordingly, μ_t and α_i are the year and country fixed effects, respectively, and ν_{it} is the disturbance. Finally, controls include possible lagged values of the news shock and $Y_{i,t}$.

As detailed in Table 1, the empirical analysis covers an extensive unbalanced panel data set encompassing 21 economies. The outcomes reveal that the association between investment and news shocks is robust to various controls and specifications. In essence, a heightened investment corresponds with the the realization of positive news shock on TFP growth in the current period, holding other factors constant. To elaborate, the regression estimate implies that news shock

[3] For robustness, I identify news shocks based on the VAR approach mentioned Kurmann and Sims (2021) and found similar results in appendix D.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
L.investment	0.720***	0.717***	0.675***	0.686***	0.692***	0.687***
	(0.037)	(0.039)	(0.051)	(0.049)	(0.049)	(0.051)
news about t	0.017***	0.017***	0.016***	0.015***	0.015***	0.015***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
news about t+1				0.008*	0.009*	0.009*
				(0.004)	(0.004)	(0.004)
news about t+2					-0.001	-0.001
					(0.003)	(0.003)
news about t+3						-0.005
						(0.003)
Constant	-0.003	-0.003***	0.031	0.038	0.042	0.042
	(0.003)	(0.001)	(0.045)	(0.043)	(0.042)	(0.042)
Country FE		✓	✓	✓	✓	✓
Year FE			✓	✓	✓	✓
Observations	433	433	433	432	431	431
R-squared	0.523	0.523	0.606	0.613	0.618	0.621
Countries	21	21	21	21	21	21
Years	22	22	22	22	22	22

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

Table 1: Dependent variable is the cyclical component of real Investment while the independent variables are news shocks, leads of news shocks, and lag of Investment. All standard errors in reported in parentheses.

received k year(s) before about a 1% increase in TFP growth today corresponds to an increased investment in percentage terms.[4] Specifications (2)-(6) include country or year fixed effects, or both, to mitigate any potential biases, whereas specifications (4)-(6) account for different leads of the news shock. The regression results from models with lead news shocks indicate that the impact gradually diminishes beyond two or more leads, indicating that the news shock anticipation horizon, based on a sample of emerging economies, approximates to k=1 year. Also, the coefficient linked to one lead of the news shock is positive, signifying that investment is also positively

[4]The investment and current account data, obtained from the World Bank national accounts and OECD National Accounts data files, respectively, underwent hp filtering to extract and employ the cyclical component of investment per capita and current account/GDP.

associated with the news shock about next periods TFP growth.

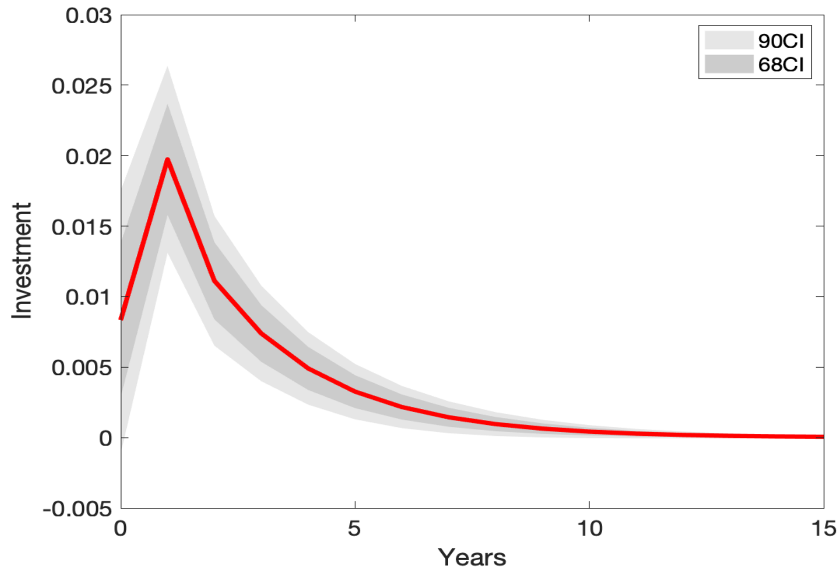


Figure 2: Empirical IRF showing the impact of TFP news shocks on to the cyclical component of real Investment in percentage changes. The figure presents the impulse response of a news shock received in year zero of a 1% increase in TFP growth in year one. The shaded regions are 90% and 68% (darker gray) confidence bands relying on Driscoll and Kraay (1998) standard errors and the delta method.

Having determined the anticipation horizon of news shocks as one year, applying the empirical methodology in column (4) of Table 1, Figure 2 showcases the dynamic responses to a positive news shock with fixed effects for country and year. Specifically, Figure 2 elucidates the investment response to a positive news shock, where the economy receives a positive news shock in year zero with a 1% increase in TFP growth in year one. The investment rate increases immediately after receiving the positive news shock. Following this, it attains its maximum in one year, where there is an actual 1% increase in TFP growth, and the impact subsides over 15 periods.

Next, Table 2 shows that a negative correlation emerges between the current account to GDP ratio and realized news shocks. To be more specific, a realized positive news shock of a 1% increase in TFP growth today, when other determinants are held constant, is associated with an increased inclination towards borrowing. Also, the regression estimates suggest that news received today about a 1% surge in TFP growth a year from now is significantly correlated to a decline today in the current account to GDP ratio, in other words, more borrowing. Similar to the investment findings, the results lose significance at two or more leads of the news shock. Again, specifications

Variables	(1)	(2)	(3)	(4)	(5)	(6)
L.current account	0.330***	0.326***	0.316***	0.317***	0.318***	0.320***
	(0.048)	(0.050)	(0.051)	(0.051)	(0.051)	(0.051)
news about t	-0.001	-0.001	-0.001*	-0.001*	-0.001*	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
news about t+1				-0.001*	-0.001*	-0.001*
				(0.001)	(0.001)	(0.001)
news about t+2					-5e-05	-1e-04
					(0.001)	(0.001)
news about t+3						0.001
						(0.001)
Constant	-4e-04	-4e-04	-0.009	-0.009	-0.009	-0.009
	(0.001)	(0.001)	(0.015)	(0.015)	(0.015)	(0.015)
Country FE		✓	✓	✓	✓	✓
Year FE			✓	✓	✓	✓
Observations	435	435	435	434	433	432
R-squared	0.102	0.102	0.182	0.190	0.194	0.196
Countries	21	21	21	21	21	21
Years	22	22	22	22	22	22

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

Table 2: Dependent variable is the cyclical component of Current Account to GDP ratio while the independent variables are news shocks, leads of news shocks, and lag of Current Account to GDP. All standard errors in reported in parentheses.

(2)-(6) incorporate country or year fixed effects, or both, to neutralize any possible distortions, whereas specifications (4)-(6) account for varying leads of the news shock.

Correspondingly, Figure 3 presents the response of the current account to GDP ratio to a positive news shock, based on the empirical methodology in column (4) of Table 2. The findings indicate that a positive news shock negatively impacts the current account to GDP ratio in the year of impact, year zero, and the years after. The effect peaks in year one, where news points to an actual 1% increase in TFP growth before returning to normal in around five periods. This result is in line with the earlier empirical regression outcomes of increased borrowing due to a positive

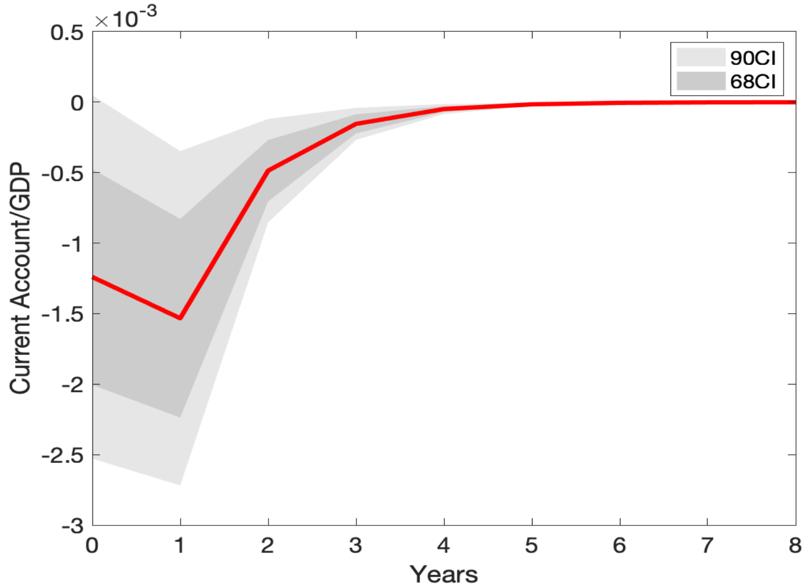


Figure 3: Empirical IRF showing the impact of TFP news shocks on Current Account to GDP ratio. The figure presents the impulse response of a news shock received in year zero of a 1% increase in TFP growth in year one. The shaded regions are 90% and 68% (darker gray) confidence bands relying on Driscoll and Kraay (1998) standard errors and the delta method.

news shock as demonstrated in Table 2.

3 Model

The model of this paper is based on the models of Mendoza (2010), Bianchi (2011), Mendoza and Villalvazo (2020), Durdu, Nunes, and Sapriza (2013), and Bianchi, Liu, and Mendoza (2016). There is a representative firm-household with preferences defined over stochastic sequences of borrowing, capital investment, consumption, and labor supply. In each period the economy receives a TFP shock and a noisy signal about next period's TFP. I refer to the latter as the "news shock." The agent's borrowing decision is subjected to a collateral constraint that allows borrowing up to a fraction of the market value of capital that he possesses.

TFP News Shock: TFP shock, ε_t^A, is assumed to follow an AR(1) process

$$ln(\varepsilon_t^A) = \rho ln(\varepsilon_{t-1}^A) + \nu_t \tag{2}$$

with $E(\nu) = 0$ and $E(\nu^2) = \sigma_\nu^2$. The process is approximated using a discrete one-period Markov chain with probabilities $p(\varepsilon^A_{t+1} = m|\varepsilon^A_t = j)\ \forall m, j \in \Theta$, where Θ denotes the probability space for the TFP shock (positive, neutral, negative). Next, news shocks s_t are defined with the structure below, where 3 shows the formulation for $p(s_t = i|\varepsilon^A_{t+1} = l)$, with $l \in \Theta$ and $i \in \Xi$, where Ξ denotes the probability space for the news shocks containing a positive, neutral, or negative news shock. Here, the probability spaces are assumed to coincide $\Theta = \Xi$.

Hence, assume that

$$p\left(s_t = i \mid \varepsilon^A_{t+1} = l\right) = \begin{cases} \eta_0 + \eta_1 \mathbb{I}_A & \text{if } i = l \\ 1 - (\eta_0 + \eta_1 \mathbb{I}_A) & \text{if } i \neq l \end{cases} \tag{3}$$

where $\mathbb{I}_A$ is an indicator function that is 1 when $s_{t-1} = \varepsilon^A_t$ and 0 otherwise. When $\eta_0 + \eta_1 \mathbb{I}_A = \frac{1}{|\Xi|}$, the signals are not informative (uniform distribution). When $\eta_0 + \eta_1 \mathbb{I}_A = 1$, the government can perfectly anticipate the TFP shock one period ahead. Note that even with $\eta_0 + \eta_1 \mathbb{I}_A = 1$ the economy faces uncertainty about the realization in two periods ahead and beyond. For simplicity and to keep the model tractable, only signals regarding next period TFP shock are considered, signals regarding other future periods are not present. Moreover, this formulation introduces persistence to the informativeness of news shocks. If the news received in the previous period accurately predicted the TFP today, then the news received today provides more precise information about TFP in the subsequent period. Otherwise, the news received today has a standard baseline precision of η_0 regarding TFP next year.

Also, this signal s_t is incorporated into the forecast of next period's TFP shock (ε^A_{t+1}). Following Bayes' theorem, the forecast conditional on current information is given by

$$p\left(\varepsilon^A_{t+1} = l \mid s_t = i, \varepsilon^A_t = j\right) = \frac{p\left(s_t = i \mid \varepsilon^A_{t+1} = l\right) p\left(\varepsilon^A_{t+1} = l \mid \varepsilon^A_t = j\right)}{\sum_n p\left(s_t = i \mid \varepsilon^A_{t+1} = n\right) p\left(\varepsilon^A_{t+1} = n \mid \varepsilon^A_t = j\right)} \tag{4}$$

with $l, j, n \in \Theta$ and $i \in \Xi$. To use an expression for the quantitative analysis of this paper, the Markov chain for the joint evolution of the TFP shock and the signal is expressed and implemented with the following formula:

$$\begin{aligned} &\Pi\left(\varepsilon^{A\prime}, s', \varepsilon^A, s\right) = p\left(s_{t+1} = \kappa, \varepsilon^A_{t+1} = l \mid s_t = i, \varepsilon^A_t = j\right) \\ &= p\left(\varepsilon^A_{t+1} = l \mid s_t = i, \varepsilon^A_t = j\right) \\ &\textstyle\sum_m \left[p\left(\varepsilon^A_{t+2} = m \mid \varepsilon^A_{t+1} = l\right) p\left(s_{t+1} = \kappa \mid \varepsilon^A_{t+2} = m\right)\right] \end{aligned} \tag{5}$$

with $l, j, m, l \in \Theta$ and $i, \kappa \in \Xi$.

Next, in the Small Open Economy, the Representative Household-Firm maximizes the following utility function [5]

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{(c_t - \frac{l_t^{\omega}}{\omega})^{1-\sigma}}{1-\sigma} \tag{6}$$

subject to the resource constraint

$$c_t + k_{t+1}(1+\tau_t^k) - (1-\delta)k_t + \frac{a}{2}\frac{(k_{t+1}-k_t)^2}{k_t} = A_t F(k_t, l_t) - q^b b_{t+1}(1-\tau_t^b) + b_t + T_t^{\tau} \tag{7}$$

To finance for the expenditure in consumption, c_t, investment and capital adjustment costs $k_{t+1}(1+\tau_t^k) - (1-\delta)k_t + \frac{a}{2}\frac{(k_{t+1}-k_t)^2}{k_t}$, the agent finances these expenditure with production, $A_t F(k_t, l_t)$, borrowing b_{t+1}. The production function in this resource constraint takes the expression $A_t F(k_t, L_t) = exp(\varepsilon_t^A)\bar{A}k_t^{\gamma}L_t^{\alpha}$, such that ε_t^A is the TFP shock.Borrowing in the current period is represented when $b_{t+1} < 0$ and has an interest rate, $q^b = \frac{1}{R_t}$ such that $R_t = \bar{R}$. A tax on debt is expressed with $\tau^b > 0$ while a tax on capital is expressed with $\tau^k > 0$. For either of this policy, a negative value denotes a subsidy instead. When a single policy of tax on capital is imposed, $T_t^{\tau} = \tau_t^k k_{t+1} + T_t^k$. Similarly, when a single policy of tax on debt is imposed, then $T_t^{\tau} = -\tau_t^b q^b b_{t+1}$. For the formulation of the competitive equilibrium, τ_k, τ_b, and T^{τ} are all set to zero. In terms of these transfers, $T_t^{\tau} > (<)0$ is a subsidy(tax) while $T_t^k > (<)0$ is a tax(subsidy) that would appear on the right hand side of (8) when the tax on capital is implemented. Also the representative agent is subjected to the collateral constraint

$$q^b b_{t+1} \geq -\kappa q_t k_t \tag{8}$$

where q_t is the price of capital and the agent cannot take on more debt than the fraction κ of the market value of capital stock, $q_t k_t$. In the sections that follow, we will also look into alternative specifications of this collateral constraint.

[5] Mendoza (2010) mentions that with an exogenous discount factor, the collateral constraint will always bind in the steady state when the rate of time preference is less than the interest rate. Conversely, the collateral constraint will never bind when the rate of time preference is more than the interest rate. This household-firm representation yields similar results to a seperate household and firm formulation that is detailed in Appendix I.

Having defined the constraints the representative agent faces, the first order conditions (assigning the multipliers λ_t and μ_t to the resource and credit constraint respectively) are expressed below

w.r.t to c_t

$$(c_t - \frac{l_t^{\omega}}{\omega})^{-\sigma} = \lambda_t \tag{9}$$

w.r.t to l_t

$$(c_t - \frac{l_t^{\omega}}{\omega})^{-\sigma}(-l_t^{\omega-1}) = -A_t F_l(k_t, l_t)\lambda_t$$

In the above formulation, the marginal product of labor is equated with the tax adjusted marginal disutility of labor. This implies that

$$l_t^{\omega-1} = \alpha exp(\varepsilon_t^A)\bar{A}k_t^{\gamma} l_t^{\alpha-1} \tag{10}$$

w.r.t b_{t+1} is the Bond Euler Equation

$$\lambda_t(1-\tau_b) = \frac{\beta \mathbb{E}_t\left[\lambda_{t+1}\right]}{q^b} + \mu_t \tag{11}$$

w.r.t k_{t+1} is the Capital Euler Equation

$$\begin{aligned} \beta\kappa\mathbb{E}_t[\mu_{t+1}q_{t+1}] = \quad & \lambda_t + \lambda_t(a)\tfrac{k_{t+1}-k_t}{k_t} - \beta\mathbb{E}_t[\lambda_{t+1}(1-\delta)] + \\ & \beta\mathbb{E}_t\left[\lambda_{t+1}(\tfrac{a}{2})\tfrac{(-2)(k_{t+2}-k_{t+1})(k_{t+1})-(k_{t+2}-k_{t+1})^2}{k_{t+1}^2}\right] - \\ & \beta\mathbb{E}_t\left[exp(\varepsilon_{t+1}^A)F_{k_{t+1}}(l_{t+1},k_{t+1})\lambda_{t+1}\right] \end{aligned}$$

The price of capital satisfies $q_t = \frac{\partial \tilde{i}_t}{\partial k_{t+1}}$, where $\tilde{i}_t = k_{t+1} - (1-\delta)k_t + \frac{a}{2}\frac{(k_{t+1}-k_t)^2}{k_t}$. Thus, $q_t = 1 + \frac{a(k_{t+1}-k_t)}{k_t}$. Plugging this in to two places on the RHS of the expression above (q_t in first line and q_{t+1} in second line)

$$\beta\kappa\mathbb{E}_t[\mu_{t+1}q_{t+1}] = \lambda_t q_t - \beta\mathbb{E}_t\left[\lambda_{t+1}\left(exp(\varepsilon_{t+1}^A)F_{k_{t+1}}(l_{t+1},k_{t+1}) - \delta + q_{t+1} + \frac{a}{2}\frac{(k_{t+2}-k_{t+1})^2}{k_{t+1}^2}\right)\right]$$

Rearranging

$$\lambda_t = \frac{1}{q_t}\beta\mathbb{E}_t\left[\lambda_{t+1}\left(exp(\varepsilon^A_{t+1})F_{k_{t+1}}(l_{t+1},k_{t+1}) - \delta + q_{t+1} + \frac{a}{2}\frac{(k_{t+2}-k_{t+1})^2}{k^2_{t+1}}\right)\right] + \frac{\beta\kappa\mathbb{E}_t[\mu_{t+1}q_{t+1}]}{q_t} \tag{12}$$

Finally, two other conditions for completeness are

$$w_t = l_t^{\omega-1} \tag{13}$$

and

$$q_t = \frac{\partial\tilde{i}_t}{\partial k_{t+1}} = 1 + \frac{a(k_{t+1}-k_t)}{k_t} \tag{14}$$

Having detailed the first order conditions, the definition of the competitive equilibrium and social planner are as follow

Definition: Competitive Equilibrium

The competitive equilibrium is defined by sequences of allocations $\{c_t, L_t, k_{t+1}, b_{t+1}\}_0^\infty$ and prices $\{q_t, w_t\}_0^\infty$ such that:

(i) Given wages, price of capital, the world interest rate, and the initial conditions (k_0, b_0), the representative agent maximizes its utility subject to the budget constraint and collateral constraint

(ii) The price of capital satisfies the expression ($q_t = \frac{\partial\tilde{i}_t}{\partial k_{t+1}}$) and wage satisfies the expression ($w_t = L_t^{\omega-1}$), which is the marginal disutility of labor

Definition: Social Planner

The social planner maximizes the utility by choosing $[c_t, L_t, k_{t+1}, b_{t+1}]_0^\infty$ subject to

(i) the resource constraint

(ii) collateral constraint

(iii) the capital pricing rule of the competitive equilibrium allocation $q_t = \frac{\partial\tilde{i}_t}{\partial k_{t+1}}$

Note that the price rule is substituted into the collateral constraint to give

$$q_t^b b_{t+1} \geq -\kappa\left(1 + \frac{a(k_{t+1}-k_t)}{k_t}\right)k_t$$

Having defined the social planner's problem, the first order conditions for the planner mainly differs in the Euler equation of capital

$$\lambda_t = \frac{1}{q_t}\beta\mathbb{E}_t\left[\lambda_{t+1}\left(exp(\varepsilon^A_{t+1})F_{k_{t+1}}(L_{t+1},k_{t+1})-\delta+q_{t+1}+\frac{a}{2}\frac{(k_{t+2}-k_{t+1})^2}{k^2_{t+1}}\right)\right])] \\ +\beta\kappa\frac{\mathbb{E}_t[\mu_{t+1}q_{t+1}]}{q_t}+\underbrace{\frac{a\kappa\mu_t}{q_t}-\frac{a\beta\kappa}{q_t}\mathbb{E}_t\left[\mu_{t+1}\frac{k_{t+2}}{k_{t+1}}\right]}_{\text{Extra term for SP compared to CE}}$$

In light of these difference, proposition 1, 2, and corollary 1 detail the optimal policy intervention that enacts the planner's allocation.

Proposition 1 *(Optimal Policy Implementation of Taxes on Capital). The policy rules of* $\tau^k_t = -\frac{[a\kappa\mu_t-a\beta\kappa\mathbb{E}_t\left[\mu_{t+1}\frac{k_{t+2}}{k_{t+1}}\right]]}{\lambda_t}$, $T^k_t=\tau^k_t k_t$, *and* $T^\tau_t=\tau^k_t k_{t+1}+T^k_t$ *can implement the social planner allocation in a decentralized equilibrium.*

Proof. See appendix G.

Proposition 2 *(Equivalence of Taxes on Debt). Alternatively, implementing policy rules on borrowing such as* τ^b_t, *and* T^τ_t *can implement the social planner allocation in a decentralized equilibrium as well.*

Proof. See appendix G.

Additionally, one can derive upon the several characteristics with regards to the expression for the optimal tax on capital.

Corollary 1 *(Sign of optimal tax policy). In the region when the collateral constraint is not binding, the optimal policy on capital investment takes the form of a positive tax or a zero tax rate.*

$$\tau_k = -\frac{[a\kappa\mu_t-a\beta\kappa\mathbb{E}_t\left[\mu_{t+1}\frac{k_{t+2}}{k_{t+1}}\right]]}{\lambda_t}$$

On one side, when the constraint is not binding and not likely to bind in the future($\mu_t=0$ *and* $\mathbb{E}_t[\mu_{t+1}]=0$*),* τ_k *is zero and no policy intervention is needed. On the other side, when the constraint is not binding but likely to bind in the future(*$\mu_t=0$ *and* $\mathbb{E}_t[\mu_{t+1}]>0$*),* τ_k *takes a positive value as* $\lambda_t\geq 0$*. This show that the optimal policy in this region is a tax. Lastly, when the constraint binds (*$\mu_t>0$ *and* $\mathbb{E}_t[\mu_{t+1}]\geq 0$*), the sign for* τ_k *depends on the terms in the numerator.*

In the subsequent quantitative findings of this paper, it points to τ_k being a subsidy when the constraint binds.

Other possible specifications for the collateral constraint can be considered as well. Specifically, the collateral constraint could take a form representing how agents can borrow based on their future value.

$$q^b b_{t+1} \geq -\kappa \mathbb{E}_t(q_{t+1}) k_{t+1}$$

This future value expression is similar to the formulation described in Ottonello, Perez, and Varraso (2022) where the competitive equilibrium achieves constrained efficiency. Section 3.5 shows that under this specification news shocks also increases the frequency of Sudden Stop episodes.[6]

3.1 Calibration

This section describes the quantitative analysis of the paper. The model is solved numerically to evaluate its quantitative predictions regarding the impact of news shocks in an emerging economy. Subsection 3.1 calibrates the model using Mexican data from 1997-2016.[7]. Data from Mexico was selected as its economy has experienced several episodes of Sudden Stops, reversal of the international capital flow. One period in the model represents a year. Next, subsections 3.2-3.7 detail the quantitative results of the paper. In terms of the results, the paper first zones into the decision rules of the competitive equilibrium and social planner in an economy with news. Then, switching the examination onto understanding and quantifying the impact of news shocks, for both a positive and a negative news shock. Finally, I will delve into the policy and welfare analysis for this paper.

For the first group of the parameters in Table 3, they were externally calibrated through the matching of the deterministic steady state of the model with the counterparts in the Mexican data moments. Firstly, the labor elasticity parameter is based on the optimality conditions of

[6] Details about the analytical derivation of the constrained efficiency result under the future value specification is shown in Appendix H.

[7] The selection of this time period is to incorporate a comprehensive time period but excluding crisis periods. Starting in the data set in 1997 and ending in 2016 exclude the Mexican Peso Crisis of 1994 to 1996 and the recent Covid Crisis 2020. Additionally, within this time frame the period of the Global Financial Crisis of 2008 to 2009 were excluded as well

labor (10) and (13) under the deterministic steady state of the model where they combine to give $l^{\omega-1} = \alpha\bar{A}k^{\gamma}l^{\alpha-1}$. After applying a log transformation to this combined expression, $\omega = \frac{log(\alpha F(.))}{log(l)}$, which gives the value for the labor elasticity after applying the parameter value for α and the data estimate of output and employment growth provided. Similarly, the interest rate is derived from the deterministic steady state capital Euler equation (12) and using the relevant parameter values listed in Table 3. As for the depreciation parameter, δ, it is set so that the capital stock obtained through the perpetual inventory method provides a capital to GDP ratio of 1.79 that is well within the range of 1.88 as estimated in Garcıa-Verdú (2005) and 1.758 as estimated in Mendoza (2010). Subsequently, the risk aversion parameter follows from the standard values related SOE papers in the literature. Similarly, the adjustment cost of capital parameter is set at 2.75, which following closely to related papers such as Durdu, Nunes, and Sapriza (2013) and Mendoza (2010). Next, α and γ are set to 2/3 and 1/3 to reflect their respective share of the GDP. As for the news precision parameters, they were derived through probit estimation of a binary variable that indicates one if the news shock was correct about next period TFP and zero otherwise. Performing the regression of this binary variable on one lag of the same binary variable, the values for η_0 and η_1 were estimated. The values point to the case that news shocks do provide information about next period's TFP but is not accurate at all times. Finally the average TFP parameter is assigned a value that provides nice convergence for the model.

Parameters, Description	Model
ω, Labor elasticity coefficient	1.80
r, Interest rate	0.06
δ, Depreciation rate	0.08
σ, Risk aversion coefficient	2.00
a, Capital adjustment parameter	2.75
α, Labor share	2/3
γ, Capital share	1/3
η_0, News precision parameter	0.43
η_1, News precision parameter	0.10
$\bar{A}$, Average TFP	5.40

Table 3: Model Parameters

Parameters, Description	Model	
β, Discount factor	0.92	
κ, Collateral constraint parameter	0.25	
Targeted Data Moments	Data moment	Model moment
Investment/GDP	0.20	0.20
Probability of Sudden Stop	0.05	0.05

Table 4: Targeted Data Moments

Moving over to the calibrated parameters shown in Table 4, the parameters for the discount factor and tightness of the collateral constraint were used to target two data moments, the investment to GDP ratio and the probability of Sudden Stops in the economy. Both the discount factor and the collateral constraint parameter help govern the model′s investment to GDP ratio and likelihood of Sudden Stops in the model. The calibrated values provide a frequency of Sudden Stops well within the range of the annual frequency values used in the literature. Next, in order to match the corresponding moments for Mexico's TFP, the auto-correlation and the standard deviation of the TFP shock process as mentioned in (2) were estimated to be ρ=0.50 and σ_v =0.03.[8]

Next, Table 5 detail key cyclical properties of the model that were not targeted. Although not the main result of this paper, these non-targeted moments provide some insights into the model performance when news shocks are incorporated. Specifically, a comparison is performed between a model with news shocks and another without news shocks. Model moments were calculated by obtaining the average of 1000 simulation periods. The data moments on real GDP, consumption, investment, current account, as shown in Table 5 are taken from the World Development Indicators (WDI) of the World Bank. [9]

In addition, the data moments point to a procyclical consumption and investment for Mexico. Current account, on the other hand, is counter-cyclical. These patterns observed in the Mexico data are similar to what is observed in emerging economies. Looking at the model moments, they also exhibit similar cyclical patterns with consumption and investment being procyclical while the current account is countercyclical. In terms of the volatility and autoregressive moments, the

[8]Based on the production function in this paper that consist of capital and labor, and using the data series on employment, population, and capital from the perpetual inventory method, the data moment for TFP can be backed out

[9]With the exception of current account, all the second moments in Table 5 were logged and linearly detrended. As current account could possess negative values, it was taken as a proportion of GDP rather than taking the log before linearly detrending.

model generates similar levels with respect to their data counterparts.

Description	Data	News Model-Baseline	News Model	No News
$\sigma(inv)/\sigma(y)$	2.690	2.618	2.571	2.552
$\sigma(ca/y)/\sigma(y)$	0.285	0.216	0.189	0.177
$\sigma(c)/\sigma(y)$	1.209	0.824	0.823	0.823
$corr(inv,y)$	0.846	0.882	0.897	0.903
$corr(ca/y,y)$	-0.247	-0.340	-0.384	-0.410
$corr(c,y)$	0.989	0.991	0.992	0.992
$\rho(inv)$	0.280	0.273	0.291	0.296
$\rho(ca/y)$	0.329	0.300	0.273	0.266
$\rho(c)$	0.443	0.643	0.648	0.647
$\rho(y)$	0.310	0.567	0.574	0.573

Table 5: Business Cycle Moments- Untargeted Moments. The second moments in this table were logged and linearly detrended. As current account could possess negative values, it was taken as a proportion of GDP rather than taking the log and performing a linear detrending.

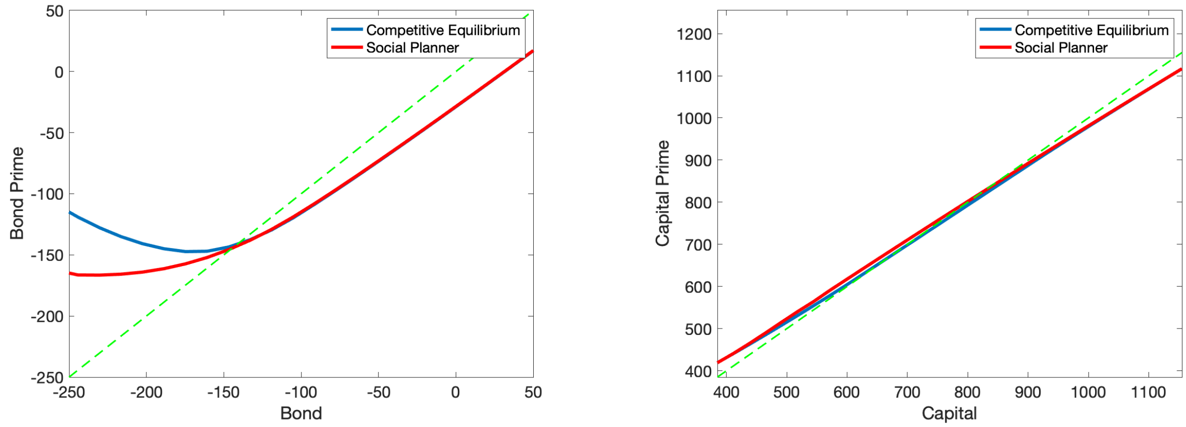
Among the models considered - those with more persistent news shocks (baseline), fixed precision news shocks, and no news shocks - the model incorporating persistent news shocks provides the best match for current account-related moments.[10] The model without news shocks exhibits low overall volatility in the current account and a higher correlation between consumption and output. These differences can be attributed to the impact of news shocks on borrowing, capital investment, and consumption, leading to greater fluctuations. Positive news shocks stimulate increased capital investment and consumption, requiring additional borrowing to finance these behaviors, given the anticipation of future higher TFP. Conversely, negative news shocks lead to decreased capital investment, consumption, and borrowing. If the news shocks turn out to be incorrect, these variables experience even larger changes. The increased fluctuations resulting from news shocks align more closely with the data moments, as reflected in Table 5. When news shocks are made persistent, the model's moments exhibit even higher volatility and lower correlation due to significant reversals and distortions caused by incorrect news. Additionally, incorporating news shocks into the model leads to a better match for autocorrelation moments.[11]

[10] The calibration for the models with fixed precision news shocks and without news shocks are detailed in the Appendix M.

[11] Akıncı and Chahrour (2018) also document in their model that a model with news provides a better match in terms of a higher autocorrelation of the current account, the comovement between current account and interest rate, and the correlation of the current account with output.

3.2 Quantitative results

Next, this subsection describes the model mechanisms through the respective bond and capital decision rules as well as their ergordic distributions.



(a) Bond Decision Rule

(b) Capital Decision Rule

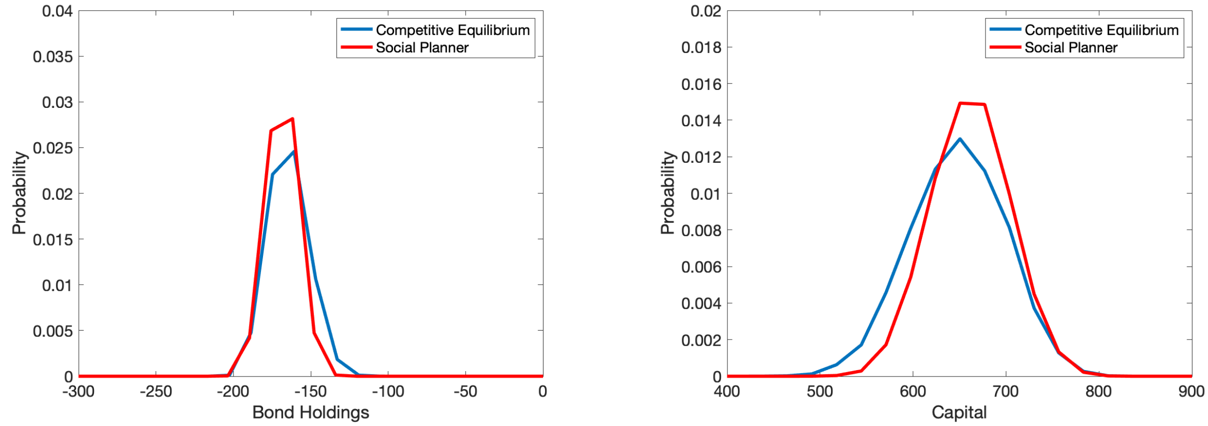
Figure 4: Bond holdings and capital decision rule for the social planner (red) and competitive equilibrium (blue).

Figure 4 displays the bond holding and capital policy rule for the planner and the private agent conditioned on a negative news shock and a neutral TFP shock. In the most right hand side of the subfigure (a), it depicts the region where the credit constraint is not binding today and not likely to bind tomorrow. In this region, the slope of the bond decision rules are flatter than the 45 degrees line meaning that the planner and the competitive equilibrium borrows more for each bond state. Notice that as we move towards the middle of this subfigure, the planner starts to accumulate less of its bond holding as compared to private agents, where the red line is slightly higher than the blue line. This behavior exhibited by the planner reflects the planner internalizing the pecuniary externality that arises due to the price of capital, q_t, that enters the collateral constraint. This pecuniary externality stems from the fact that private agents are unable to recognize how their borrowing choices through general equilibrium effects will influence the price of capital. The social planner, on the contrary, internalizes this externality and reduces its borrowing behavior and hence the subsequent investment in capital. A reduction in investment before a crisis alleviates the negative impact of a severe fall in investment once the crisis occurs. Preventing a drastic fall in investment of capital during a crisis is beneficial as it prevents the price of capital from falling too much and cause further tightening of the collateral constraint, which will amplify the impact of the crisis.

Finally, on the most left hand side of the subfigure (a), it denotes the region when the collateral constraint is binding. In this region, the planner understands the social benefit of holding more capital. Holding more capital can help relax the constraint during crisis times through the price of capital and allow the constraint to not contract as much. Thus, the planner has the ability to affect the price of capital that goes into the collateral constraint, which enables the planner to not lose as much of its bond holding during a crisis as compared to the private agent. The differences that can be observed in the bond holding decision rule highlight the inefficiencies that arises both when the constraint is binding and not binding, where the ex-post inefficiency is of a larger magnitude. Related papers such as Bianchi (2011) only detail the ex-ante inefficiency in their model with the planner and private agents due to the assumptions that the planner cannot affect the key price that enters the collateral constraint and that the planner shares the same allocation as private agents when the constraint binds. Hence, there is no room for ex-post policy intervention in this paper.

To complement the analysis of borrowing decisions in this model, subfigure (b) of Figure 4 showcases the capital decision rules for the planner and competitive equilibrium. On the left half of the figure, the capital decision rules are located higher than the 45 degrees line to express the characteristic of investing in more capital for each of the low capital states in this region. Generally, the planner decision rule lies above the decision rule of the competitive equilibrium to point out that the planner invest in more capital for most of the capital state. Reaching the rightmost region of the figure, where the decision rules are below the 45 degrees line, it implies that the planner and the private agents tends to invest in less capital for each of this high capital states.

Figure 5 shows the ergodic distributions for bond holdings and capital. The distributions for the social planner are denoted in red and the competitive equilibrium in blue. The social planner's bond distribution lies to the left of the competitive equilibrium's bond distribution to signify that the competitive equilibrium underborrows. While the planner's capital distribution is to the right of the competitive equilibrium to show that the planner invest more in capital than private agent. Based on the bond and capital decision rule as discussed earlier, the extra term in the capital Euler equation above seems to say that planner has additional benefit from holding capital, especially when the constraint is binding. Hence, on average, the figure shows that the planner accumulates



(a) Ergodic Bond Distribution

(b) Ergodic Capital Distribution

Figure 5: Ergodic bond holdings and capital distributions for the social planner (red) and competitive equilibrium (blue).

more capital. Although the social planner internalizes the cost associated with the pecuniary externality from the price of capital, q_t, and borrows less in states that the collateral constraint is likely to bind in the next period, it has more bond holdings during bad times as it realizes that it can affect the price of capital that enters the collateral constraint. In other words, the planner borrows less in normal times but is able to mediate the impact of the crisis and hold on to more bonds in crisis times. Thus in general, the planner borrows more than private agents. Also, the difference in the distributions between the social planner and private agent seems small.However, this small deviation makes a big difference in terms of welfare because the major discrepancies lie on the region when when the collateral constraint is binding, which the planner experiences in low frequency.

3.3 IRFs- Positive vs Negative TFP News

Having described the decision rules and corresponding distributions, this section aims to zoom into understanding the quantitative implication of different shocks that the planner and competitive equilibrium could receive. Specifically, delving into impulse response functions to study how a positive or negative news shock conditioned on the constraint not binding in the initial period.[12]

[12]In appendix K and L, the results of news shocks conditioned on the constraint binding in the initial period, and the case of TFP shocks are presented. Conditioned on the constraint binding, a positive news shock as compared to a negative news shocks can aid in recovery.

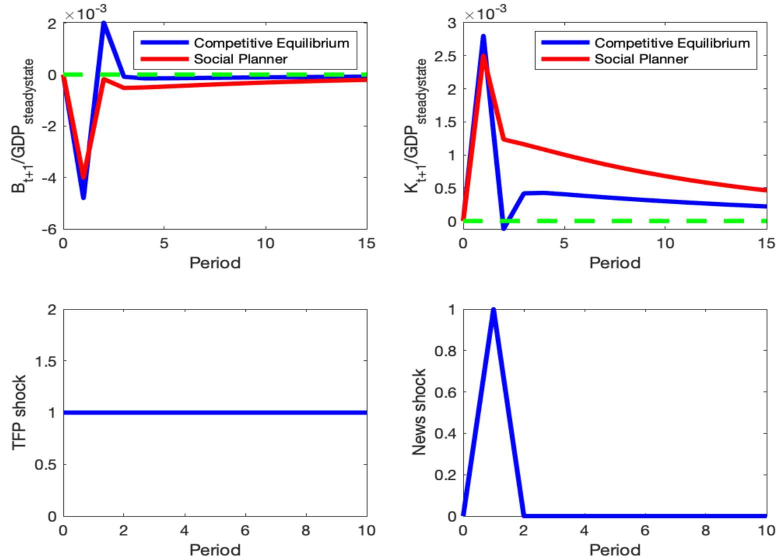


Figure 6: Positive News Shock. Conditioned on the collateral constraint not binding in time zero, this figure shows the impulse response function to a incorrect positive news shock at time one on the bond to steady state GDP (top left) and capital to steady state GDP (top right) ratios for both the social planner (red) and the competitive equilibrium (blue).

First, Figure 6 details the impulse response function to a positive news shock for the bond to steady state GDP and capital to steady state GDP ratios of both the planner (red lines) and the competitive equilibrium (blue lines). The economy starts off in an initial state when the collateral constraint is not binding and the manner of the shocks for the impulse response function of this figure is as follows. At time zero, TFP is one and the news shock is neutral, analogous to the economy not receiving any shocks. Then at time one, there is a one-time positive news shock while the TFP shock remain at one. As shown in the figure, a one time positive news shock causes an increase in borrowing and capital investment. When the planner or private agents receive a positive news shock today, they increase their investment in capital today so that more capital can be used for output tomorrow, where it is likely that TFP will be high. To finance for the increase in capital, there is an increase in borrowing today as well. From time two onwards, the economy receives no more news shocks and TFP continues to stay at one for the rest of the period. Note that despite receiving positive news in time one, actual TFP does not increase in time two, thus pointing to the economy receiving a incorrect positive news shock, where positive news today did not accurately predict actual TFP in the next period. The results of this incorrect positive news shock shows that from time two onwards, borrowing and capital reduces.

A comparison of the planner and competitive equilibrium shows that for a positive news shock, the planner borrows and invests slightly less than private agent at the time of the positive news shock. When the economy in time two realizes that the positive news shock received at time one was incorrect, the competitive equilibrium reduces its borrowing and investment more than the planner, which can be seen in the steeper drop. This figure encompasses the impact of the constraint binding because once the planner or private agents realize that the positive news they received in the previous period was incorrect, it is likely to cause the collateral constraint to bind in subsequent period(s). Specifically after time two for the competitive equilibrium, borrowing and more strikingly investment in the competitive equilibrium both drop past its steady state level before going back to indicate that some paths that this impulse response function was averaged on faced a binding collateral constraint. This result points to the insight of what causes the model with news shocks to exhibit higher probability of a Sudden Stops as we will see quantitatively in later sections.

Next, Figure 7 details the impulse response function to a negative news shock for the planner (red lines) and the competitive equilibrium (blue lines). The difference to the positive news shock is that at time one, there is a one-time negative news shock instead while the TFP shock remain at one. As shown in the figure, a one time negative news shock causes a decrease in borrowing and capital investment. When the planner or private agents receive a negative news shock today, they decrease their investment in capital today so that less capital will be used for output tomorrow, where it is likely that TFP will be low. With less need to invest, there is a decrease in borrowing today as well. Again, the news shock is a incorrect one as actual TFP does not actually decrease in time two. As a result of the economy understanding that it was a incorrect negative news shock, borrowing and capital increases back to its steady state level from time two onwards.

Furthermore, comparing between the planner and competitive equilibrium, the planner is able to hold on to more borrowing and investment than private agent at the time of the negative news shock. A negative news shocks does not seem to increase the likelihood of a Sudden Stops in

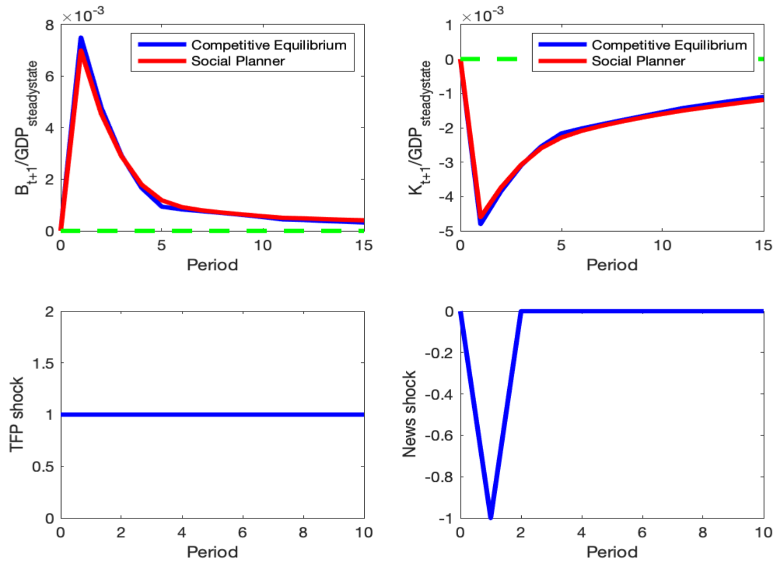
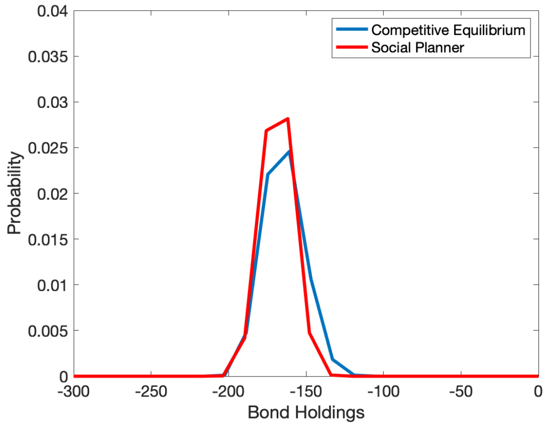


Figure 7: Negative News Shock. Conditioned on the collateral constraint not binding in time zero, this figure shows the impulse response function to a incorrect negative news shock at time one on the bond to steady state GDP (top left) and capital to steady state GDP (top right) ratios for both the social planner (red) and the competitive equilibrium (blue).

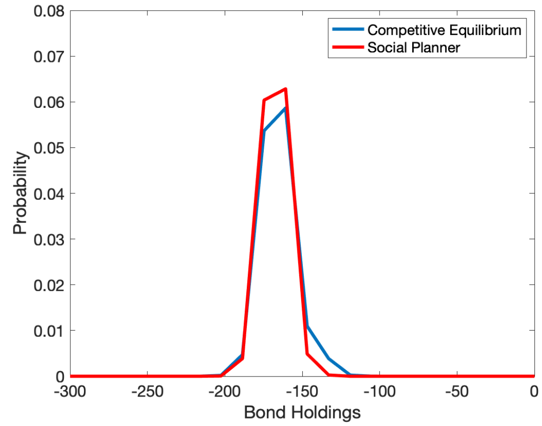
future periods as the planner and private agents can adjust quickly to engage in more borrowing and investment once they realize that the news was incorrect at time two. Also, as the difference between the private agent and planner is small, it exemplifies that the distortion from Sudden Stop episodes due to incorrect negative news is smaller than the episodes caused by the incorrect positive news shocks.

3.4 Probability of crisis and comparison to no news model

After detailing the quantitative findings of a positive or negative news shocks from the impulse response functions. This subsection aims to compare the effects of news shock in general. In other words, the bond and capital distribution for the model of this paper without news shocks is shown. In terms of the calibration, the model with no news shock adopts the same parameter values but removes news shocks so the economy only receives TFP shocks.

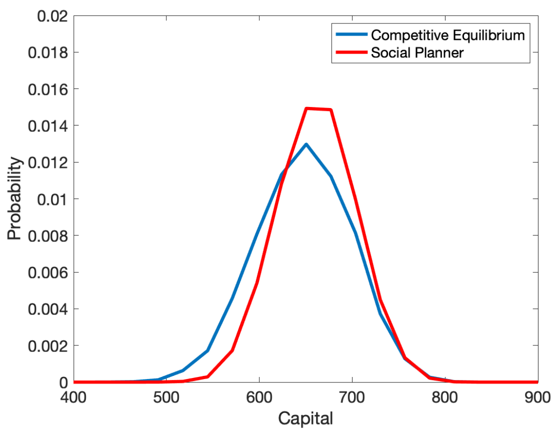


(a) Model with News Shocks

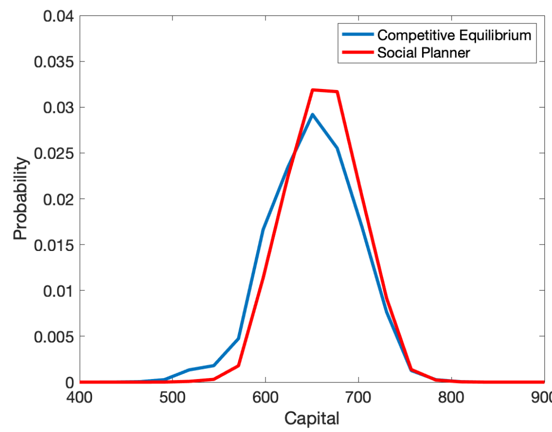


(b) Model without News Shocks

Figure 8: Ergodic Bond Distribution -News vs No News



(a) Model with News Shocks



(b) Model without News Shocks

Figure 9: Ergodic Capital Distribution -News vs No News

Figures 8 and 9 show for the model with and without news shock their respective bond and capital distribution. For one, the range of the distribution for the model with news shock is slightly wider. On top of that, the y axis value of this figures point out that the model with news exhibit distributions that are shorter and have fatter tails. This observation is in line with earlier results that show how a positive news shock will increase borrowing and investment while a negative news shock will decrease borrowing and investment. Hence, generalizing that for both of these news shock, it leads to the fatter tails that represent more extreme events in the model with news shocks. Therefore, this leads to the finding that news shocks cause more volatility to the economy.

In relation to Sudden Stops events, Table 6 provide further quantification of the impact of news shocks. When news shocks are removed from the model, both the planner and competitive equilibrium face noticeable lower probability of a crisis. Recalling from the results for the impulse response function of a positive news shock, during normal times a incorrect positive news shock as

Model	Probability of Crisis
Competitive Equilibrium -News(Baseline Calibration)	0.053
Social Planner -News(Baseline Calibration)	0.045
Competitive Equilibrium -No News	0.045
Social Planner -No News	0.040

Table 6: Probability of Crisis

shown earlier cases a sharp reversal in borrowing and investment that roots from increased likelihood of a binding constraint. Thus, the incorrect positive news shock is the main culprit for the susceptibility of a crisis in the economy with news shocks. Again, this also explains the distribution results that showcases fatter tails for the model with news shocks.

3.5 An alternative collateral specification-future value

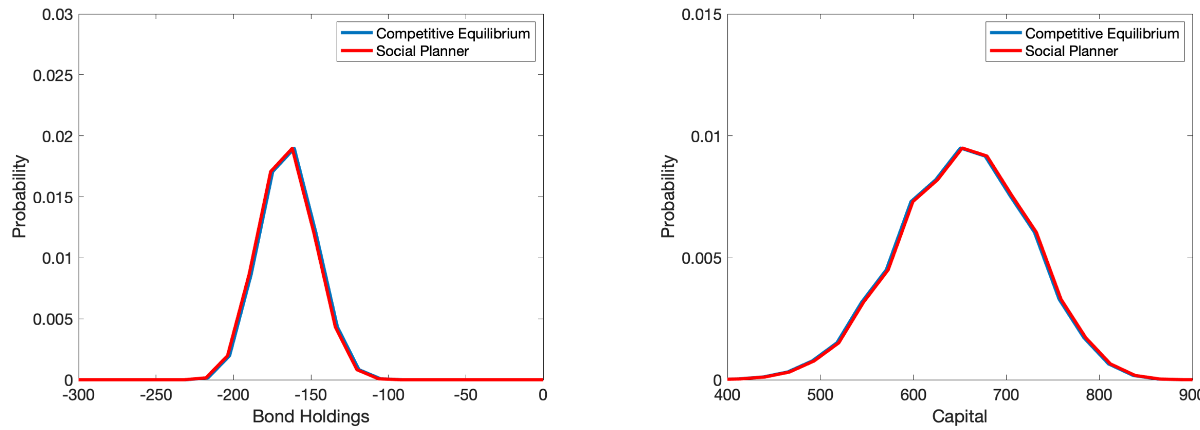
In light of the recent empirical work in the literature by Lian and Ma (2021) that question whether credit constraints are based on the borrower's current value or future value. They argue that through their data set on the United States corporate debt, they find that majority of the debt was collateralized based on the cash flow of the continuing operations tied to future value rather than the liquidation value of assets that the firm possess.[13] Similarly, Camara and Sangiacomo (2022) use their Argentinian credit registry data set and also show that a good majority of firms borrow based on cash flows.[14] In line with these recent empirical findings, Ottonello, Perez, and Varraso (2022) provide a theory on the comparison of collateral constraint based on current value or future value. They find that under a future value constraint, the borrowing inefficiency no longer exists as the planner has no room to relax the collateral constraint.

For the model of this paper, Figure 10 depict a similar finding as Ottonello, Perez, and Varraso

[13] Lian and Ma (2021) mention in their paper two types of lending: asset-based and cash flow-based. They find the latter being more prevalent.

[14] Camara and Sangiacomo (2022) establish that the debt that firms in Argentina engages in are tied to a debt limit based on the firm's interest payments to cash flows ratio.

(2022) because there exist meager to no difference in the bond and capital distribution of the planner and the competitive equilibrium. In the future value specification of the collateral constraint, loosening tomorrow's collateral constraint requires more investment in capital two periods from now. In order to do so, the planner has to reducing the amount of borrowing tomorrow, which goes against the planner also trying to borrow more tomorrow. Hence we see the distributions of the planner lying on top of the competitive equilibrium.



(a) Ergodic Bond Distribution

(b) Ergodic Capital Distribution

Figure 10: Bond and Capital Distributions under future value specification

Model	Collateral Specification	Probability of Crisis
News		
Competitive Equilibrium	$-\kappa q_t k_t$	0.053
Social Planner	$-\kappa q_t k_t$	0.045
Competitive Equilibrium	$-\kappa \mathbb{E}_t(q_{t+1})k_{t+1}$	0.048
Social Planner	$-\kappa \mathbb{E}_t(q_{t+1})k_{t+1}$	0.048
No News		
Competitive Equilibrium	$-\kappa q_t k_t$	0.045
Social Planner	$-\kappa q_t k_t$	0.040
Competitive Equilibrium	$-\kappa \mathbb{E}_t(q_{t+1})k_{t+1}$	0.041
Social Planner	$-\kappa \mathbb{E}_t(q_{t+1})k_{t+1}$	0.041

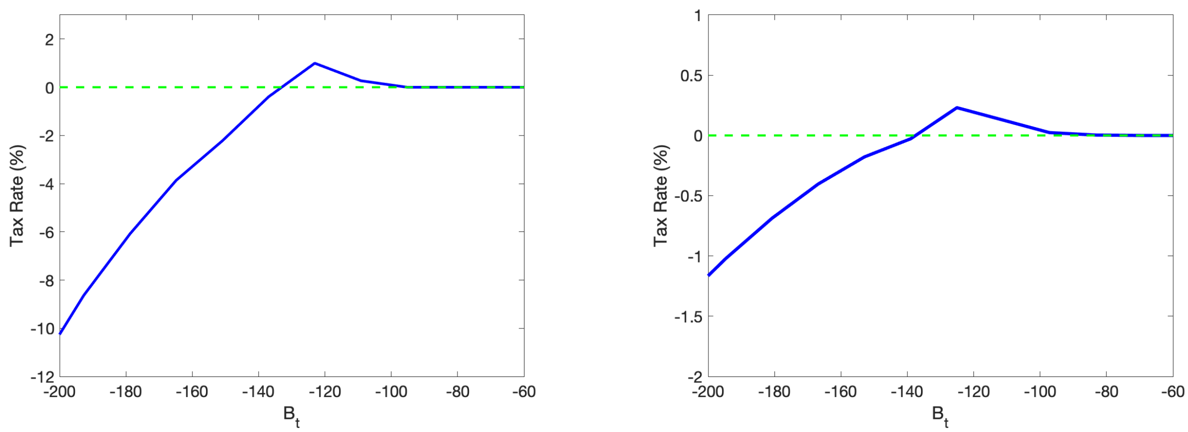
Table 7: Probability of crisis under different collateral constraint specifications

To supplement the results in Figure 10, Table 7 provide a comparison of the probability of crisis for the future value constraint specification and the current value specification as mentioned in Mendoza (2002), Bianchi (2011), Bianchi and Mendoza (2018). As can be inferred from Figure

10, the probability of crisis for the planner and competitive equilibrium is almost the same in the future value specification. More importantly, Table 7 provides one of the main results of this paper by showing that for either of the collateral constraint specification, news shocks nevertheless causes financial instability in the form of a higher frequency of Sudden Stops.

3.6 Policy Analysis

As discussed earlier, the decision rules of the planner together with proposition 1 explain that the planner differs from CE both when constraint is binding and when it is not. Hence, an optimal policy that covers both when constraint is binding and when it is not is examined in this section.



(a) Policy Tax Rate- Optimal Tax on Debt

(b) Policy Tax Rate- Optimal Tax on Capital

Figure 11: Optimal policy tool averaged over all news shocks. Subfigures (a) and (b) show the policy tool targeted at the borrowing and investment respectively. Positive value represents a tax while a negative value represents a subsidy.

Figure 11 shows the optimal tax rule required to decentralize the social planner's problem. As highlighted in propositions 1 and 2, the optimal policy can be of the the form of a tax on debt and a lump sum transfer, τ_t^b and T_t^τ, or a tax on capital in conjunction with two other lump sum transfer, τ_t^k, T_t^τ and T_t^k. The figure shows that for both the tax on debt and tax on capital, it is optimal to implement a tax when the collateral constraint is not binding as shown with the positive tax values and implement a subsidy when the collateral constraint is binding as shown with the negative value in the region where there is higher levels of borrowing. The reason behind such an implementation is a result of the behavior of the planner. Just like the planner, a tax in the region where it is not binding today but likely to bind in the next period can reduce the likelihood of facing the severe effects of a crisis. Then, a subsidy when a crisis occurs can promote holding on to more investment in capital so that the collateral constraint will not tighten as much.

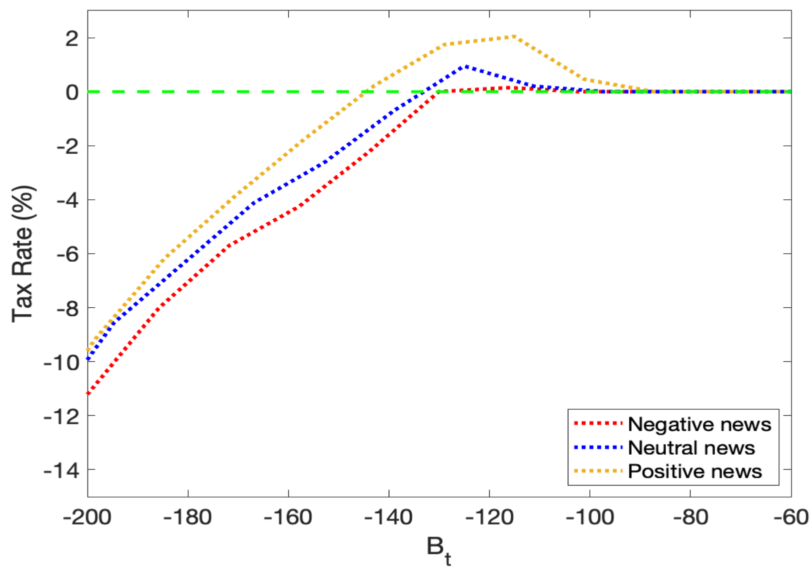


Figure 12: Policy Tax Rate- Optimal Tax on Debt conditioned on different news shocks

Figure 12 shows the asymmetries between the optimal tax on debt that depends on the type of news shock that the economy receives. As explained earlier, good news in normal times causes borrowing inflows, which motivates more prudence. While a negative news shock immediately causes outflows in borrowing, requiring a smaller tax rate on debt to lessen the likelihood of future crisis. On the other hand, towards the left of the figure where the constraint binds, good news requires less subsidy than negative news because good news can aid a faster recovery while bad news might exacerbate the effects of the crisis.

3.7 Welfare Gain

In order to quantify the effects of implementing the optimal policy, the value functions for the planner and competitive equilibrium respectively are needed to be defined first as shown below

$$v^{SP}\left(b_t, k_t, \varepsilon_t^A, s_t\right) = \frac{1}{1-\sigma}\left(c_t - \frac{1}{\omega}(L_t)^{\omega}\right)^{1-\sigma} +$$
$$\beta E\left[v\left(b_{t+1}, k_{t+1}, \varepsilon_{t+1}^A, s_{t+1}\right) \mid \varepsilon_t^A, s_t\right]$$

$$v^{CE}\left(b_t,k_t,\varepsilon_t^A,s_t;\chi\right)=\frac{1}{1-\sigma}\left((1+\chi)c_t-\frac{1}{\omega}(L_t)^{\omega}\right)^{1-\sigma}+$$
$$\beta E\left[v\left(b_{t+1},k_{t+1},\varepsilon_{t+1}^A,s_{t+1},\chi\right)\mid\varepsilon_t^A,s_t\right]$$

Then, the welfare gain can be found through deriving the value of χ by solving the nonlinear equation below

$$v^{SP}\left(b_t,k_t,\varepsilon_t^A,s_t\right)=v^{CE}\left(b_t,k_t,\varepsilon_t^A,s_t;\chi\left(b_t,k_t,\varepsilon_t^A,s_t\right)\right)$$

where χ is the consumption equivalent term of how much is needed so the the competitive equilibrium is indifferent to the planner. The quantitative results of χ is expressed in Figure 13

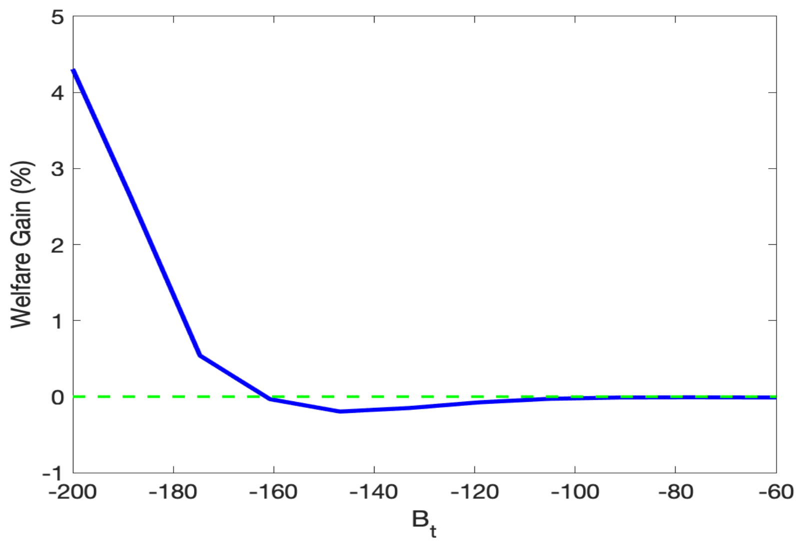


Figure 13: Welfare Gain from implementing the optimal policy

Model	Tax Rate(Not Binding)	Tax Rate(Binding)	Welfare Gain
News			
Tax on Debt	0.007	-0.057	0.007
No News			
Tax on Debt	0.003	-0.049	0.004

Table 8: Welfare Gain and Tax Rate-Numerical Simulation

The results in Figure 13 corresponds to the optimal tax rule shown earlier in Figure 11. In terms of the welfare, there are welfare losses when the collateral constraint is not binding while welfare gains when collateral constraint binding. Also, Table 8 provides the welfare results on the ergodic distribution through time simulation for both the model with and without news shocks. It is shows that the tax rate under the news shocks model is of a slightly higher magnitude and consequently point to a slightly higher welfare gain.

4 Conclusion

This paper examines the impact of persistent news shocks in a model with an occasionally binding constraint. News shocks that the economy receives today provide information on what the next period's TFP will likely be. This news shock also influences borrowing and capital investment decisions during this period subjected to the collateral constraint of the model, which contains the price of capital. This price of capital in the collateral constraint gives rise to a pecuniary externality that could increase the susceptibility to a Sudden Stops event. Unlike an actual TFP shock, news shock does not increase income today as future income is not realized yet. Hence, if the economy, for instance, receives a positive news shock to finance for an increase in capital investment to be used for future production, more borrowing is required today. This can cause the economy to be more vulnerable to future adverse shocks if the higher TFP in the future does not realize.

The main quantitative contributions of this paper show that news shocks cause higher probability of Sudden Stops in the economy for both collateral constraint specifications, future or current value. A positive news shock leads to higher borrowing and investment, while a negative news shock leads to lower borrowing and investment, causing fatter tails in the distributions of bind and capital. Moreover, incorrect news that did not provide accurate information about future TFP contributes to volatility. During normal times, a incorrect positive news shock, where higher TFP in the future turns out to be incorrect, leads to a contraction in borrowing and investment as the likelihood of the constraint binding in the future increases. On the other hand, in bad times, a positive news shock can aid the recovery back to the steady state faster. Finally, the planner allocation points to optimal policy intervention through a tax when the constraint is not binding and a subsidy when the constraint is binding. In the presence of news shocks, it promotes policy makers to engage in an active policy stance.

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