Economics Bulletin

Volume 42, Issue 4

Modeling 2018 currency crisis of Turkey: A balance of payments approach

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Abstract

The episodes of excessive depreciation of Turkish Lira and the currency crisis in 2018 have revealed increased vulnerabilities of Turkish Financial Markets to external shocks in recent years. A new modeling framework that allows integration of flow of funds recorded in balance of payments has been developed. The model not only successfully explains short-term dynamics of exchange rates, it also shows how episodes of excessive depreciation can be linked to external factors. Our results show that reliance on hot money flows, after quantitative easing policies by the major central banks in 2011 has contributed to the build-up of stocks of FX liabilities, which are subject to reversals and sudden stops in the short run. The results reveal how changes in Fed Rate or some other event of international significance may spur FX outflows from these stocks that can cause an excessive loss in the value of Turkish Lira. Simulation results of several scenarios have also shown that the Central Bank of Turkey may counter the reversals by raising its policy rates. However, this can at times be pro-cyclical and may contribute to macroeconomic instability. The preliminary results which are presented in this paper as a case study of Turkey may also have policy significance for the central banks in other emerging markets.

Citation: Seyid Fahri Mahmud and Seyid Amjad Ali and Fatih Furkan Akosman, (2022) "Modeling 2018 currency crisis of Turkey: A balance of payments approach", *Economics Bulletin*, Volume 42, Issue 4, pages 1955-1964
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Submitted: February 22, 2022. **Published:** December 30, 2022.

1. Introduction

The exceptional measures taken by the central banks in the major advanced economies (AEs), after the global financial crisis in 2008, and the subsequent volatile short-term capital flows into emerging markets (EMs) have rekindled the academic debate about the cross border financial spill overs and the ability of the central banks in EMs to protect their financial markets from external shocks (Mano and Sgherri 2020, and Ahmed and Zlate 2014). It has been recently suggested that "independent monetary policies are only possible if and only if the capital account is managed" (Rey 2016). In other words, the ability of central banks in EMs to set their policy rates under flexible exchange rate alone does not ensure financial stability (Obstfled, Ostry and Qureshi 2017)[1]. Turkey, like many other EMs, was also exposed to such volatile flows and the Central Bank of Turkey (CBRT) took new measures to address its concerns of financial stability. However, despite the introduction of new macro-prudential measures in 2011, recent episodes of excessive depreciation of Turkish Lira against USD and currency crisis of 2018 has made another mark in the series of financial crises that afflicted the international financial markets in past. The international markets have seen such crises in the past, the 1994 Mexican and Argentinean Currency Crises, the 1994 East Asian Currency Crash and the 1999 Brazilian Currency Crisis.

In this paper, we argue that Turkey's long term current account deficit and the nature of the sources of its financing may help explain frailty of financial market in recent years. There has been a remarkable shift in the modes of the financing from direct and long-term to portfolio and short-term. For example, from an average of over 80 percent between 2006-2010, the contribution of direct and long-term external financing went to an average of 39 percent during 2011-2014 period. 75% of the total external financing, the contribution of direct and long-term financing. The sustained inflows of 'hot money', the short-term net flows into portfolio investments, have contributed to the build-up of stocks of FX liabilities that are subject to reversals and sudden stops. From 90 Billion USD in 2010, the stocks of short-term external liabilities increased to over 190 billion USD. Preliminary examination of these dynamics indicates that periods of excessive depreciation of the currency can be linked to reversals from these short-term stocks of liabilities.

In this present work, our primary contention is that the accumulation of large stocks of short-term FX liabilities that are subject to reversal(s) in a short period of time have made financial markets more vulnerable to external shock(s) or other event of international significance and central bank responses to maintain financial stability may come at the expense of macroeconomic stability.

In this paper, we further expand and develop stock-flow modeling approach of Yamaguchi and Yamaguchi (2020) in explaining the short-term dynamics of nominal exchange rate. Modeling approach primarily uses the supply and demand for foreign currency (FX) based on cross border financial transactions recorded in the balance of payments in determining the dynamics of nominal exchange rate. Although we report results of our core exchange rate model in this short-paper, a more comprehensive integrated system dynamics model that includes sub-modules of the main components of balance of payments, including current accounts and financial accounts, is also being developed.

[1] The post-2008 developments with extraordinary rise in highly volatile cross-border capital flows have raised doubts about the effectiveness and applicability of 'Trilemma', a trade-off presented by Mundell-Fleming Model as a guide to policy makers (Mundell 1963).

The core model of exchange rate, reported in this paper, also develops and integrates a sub-module of stocks of FX liabilities pertaining to the net inflows of non-resident investments in debt securities (DS)[2]. The dynamics of the stocks of DS is then explained by external factors such as Federal Reserve Rate and VIX and Policy Rates of CBRT. The optimized integrated model is then employed to carry out scenario analyses to simulate financial vulnerabilities that can be linked to the external factors. Despite the simplicity of the model, the core model helps in understanding the main sources of financial vulnerabilities of the Turkish Financial Markets and can help in explaining the currency crisis of 2018. To the best of our knowledge, this paper is a first comprehensive modeling attempt that utilizes balance of payments and System Dynamics to study short-term dynamics of nominal exchange rate of a country.

The remaining parts of this paper are organized as follows. In section 2, we present the core model of exchange rate and modeling of the stocks of FX liabilities related to DS. In section 3, we discuss data and results of our model. Finally, concluding remarks are provided in section 4.

2. Model

In accordance with the international practices (IMF 2009), the transactions in BOP can be presented in a simple equation as:

$$CA_t + CAP_t + EO_t = FA_t + RES_t \quad (1)$$

In (1), the left hand side records the sum of current account (CA) and capital accounts (CAP), corrected for any errors and omissions (EO). On the other side of the equation, Financial Accounts (FA), record net financial flows related to investments of residents abroad and net financial flows of non-residents investments in the country[3].

Turkish records of BOP in our sample, shows that capital account (CAP) has almost no recorded transactions. Assuming errors and omissions (EO) zero for simplicity, we can re-write (1) to illustrate the interconnectivity between current account (CA) and financial account (FA):

$$CA_t - FA_t = RES_t \quad (2)$$

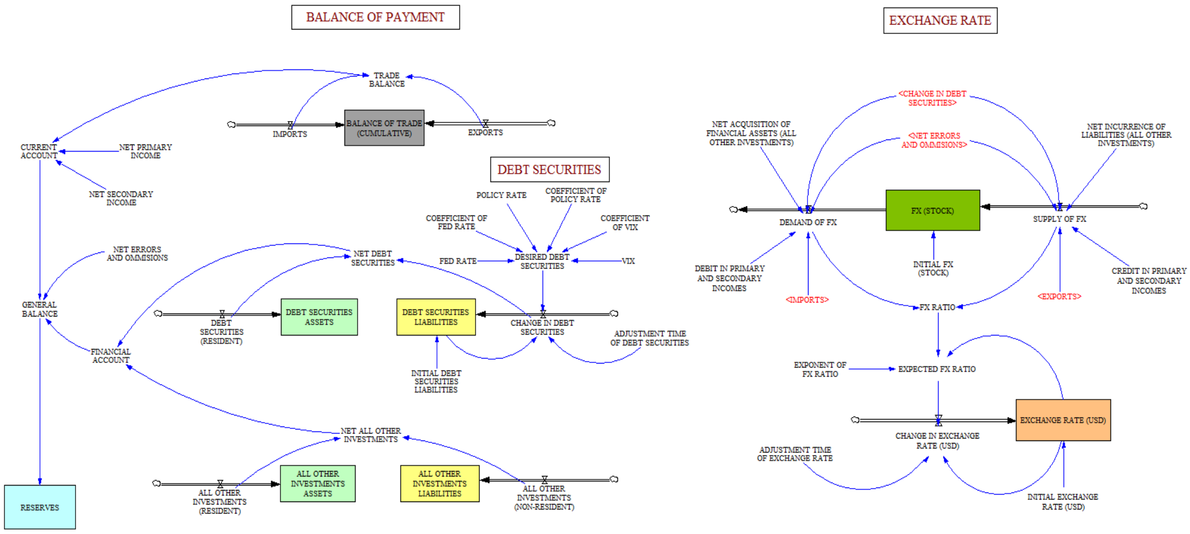
RES in (2) captures the imbalances of payments in BOP or FX international imbalances. A positive RES, for example, shows excess FX liquidity and vice versa[4]. The exchange rate module employs FX international imbalances to explain the short-term dynamics of exchange rate. The partially integrated core model of exchange rate is shown in Figure 1.

[2] In a more comprehensive integrated model, other components of balance of payments have also been modelled and integrated into the system.

[3] The ‘net acquisition of assets’ by residents and the ‘net incurrence of liabilities’ to non-residents are recorded under different headings: Direct Investments, Portfolio Investments and Other Investments.

[4] RES also reflects instruments available to the central bank for financing or absorbing an imbalance. However, flexible exchange rates can, in theory, adjust in response to the imbalances (IMF 1996).

Figure 1. Partially Integrated-ER Model.



The model equations of Exchange Rate Module in Figure 1 are as follows:

$$FX\ Ratio = \frac{D_t^{fx}}{S_t^{fx}} \tag{3}$$

$$ER_t^e = \frac{ER_{t-1}}{FX\ Ratio^{\epsilon}} \tag{4}$$

$$\frac{dER_t}{dt} = \frac{ER_t^e - ER_{t-1}}{t^{Adj}} \tag{5}$$

where D_t^{fx} and S_t^{fx} are Demand for FX and Supply of FX, respectively. The ER Basic Model (3-5) has three basic parameters to be optimized; initial ER, exponent of $FX\ Ratio$ (ϵ) and time to adjust (t^{Adj}).

$FX\ Ratio$, in (3) is a measure of excess demand of FX and an increase in the ratio will indicate upward pressure on ER and vice versa. The model equation of expected exchange rate, ER_t^e, in (4) is based on the ratio of last period ER and FX Ratio. The parameter ϵ, captures the elasticity of changes in expected ER to the FX Ratio. We expect parameter ϵ to be negative as excess demand of FX will lead to higher expected value of, ER_t^e in (4). Finally, (5) is a differential equation capturing the dynamics of ER with time to adjust as a parameter of the model.

In the first stage of optimization, all inflows (supply) and outflows (demand) of FX documented in the BOP have been used as input data, and the ER model in (3) and (4) have been optimized. One of the key parameters in this optimization is exponent of $FX\ Ratio$ (ϵ), the elasticity of changes in expected ER to the FX ratio. The overall simulation of the model, based on input data in BOP significantly explained the short term dynamics of ER.

In the second stage, the Core ER Model has been integrated with the Sub-module of DS. In Figure 1 the Sub-module of DS has been shown. The Sub-module is also explained in (6) and (7). In (6), DS_t^d is the desired stock of debt securities by non-residents that depends on Fed Rate, VIX, which is the volatility index, and policy rate of CBRT. *A priori* we expect the coefficients of Fed Rate and VIX to be negative while positive for the policy rate of CBRT. The differential equation in (7) with time to adjust parameter determines the net flows of debt security investments.

The DS Sub-module is also depicted in Figure 1 and following are its main equations:

$$DS_t^d = \theta_1(FED_t) + \theta_2(POLICY_t) + \theta_3(VIX_t) \quad (6)$$

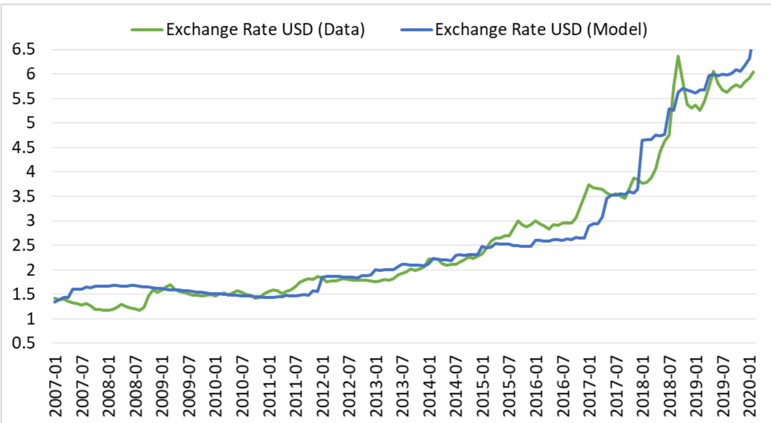
$$\frac{dDS_t}{dt} = \frac{DS_t^d - DS_{t-1}}{t^{Adj}} \quad (7)$$

Integration of DS Sub-module into the core model has facilitated in linking net FX flows to the external factors, such as Fed Rate and VIX. It also allows modeling the balancing impact of changes in the policy rates of the central bank. Although other components of BOP have not been modeled in this paper, the model provides a simple framework to carry out relevant scenario analyses to understand the primary sources of vulnerabilities related to hot money flows of the Turkish Financial Markets.

3. Data and Discussion of Results

EVDS, data central of CBRT, has been one of the primary sources of data employed in this study[5]. Monthly data of BOP has been taken from EVDS starting from January 2007 up to February 2020[6]. We have used Powell Method to optimize (Vassiliadis and Conejeros 2008). The constructed modules are being calibrated to fit to the historical data. Figures 2 and 3 present model simulations. Both simulations show a reasonably good fit with coefficients of determinations of 95.5% and 88.1%, respectively. All the signs of coefficients have also been according to the expectations. Significance of results have been assessed based on sensitivity analysis. The results evidently show that model is able to capture the dynamics satisfactorily at ±5% deviation (see Figure A1 in the Appendix).

Figure 2. Partially Integrated Model Simulation Results and Summary Statistics.

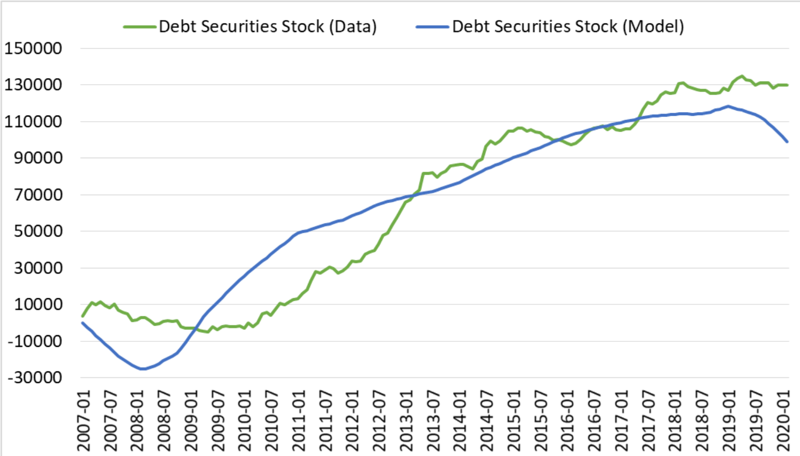


R^2 = 0. 955, RMSE = 0.300, ***Optimized values:*** *INITIAL ER= 1.337, ADJUSTMENT TIME OF ER = 120.781, ϵ = -10.436*

[5] https://evds2.tcmb.gov.tr/

[6] The sample period includes only the pre-pandemic months in this paper. In our ongoing research, a separate analysis of post-pandemic period has been carried out.

Figure 3. DS Sub-Module Model Simulation Results and Summary Statistics (Millions USD).



R^2 = 0. 881, RMSE = 17385.6, ***Optimized values:*** *INITIAL DS LIABILITIES = 0.0018, ADJUSTMENT TIME OF DS = 729.872, θ_1 = -877183, θ_2 = 108735, θ_3 = -1.1366*

In the second stage, the Partially Integrated ER Model has been employed to carry out several scenario analyses. Two scenarios of Fed Rate and two scenarios of Policy Rate are being shown in Figure 4. A sustained increase in Fed Rate from 2.5 to 3.5 (Scenario 1) causes reversals from DS and fast depreciation of Turkish Lira in a short period of time. The Turkish Currency Crisis of 2018 (April 2018-October 2018), when Turkish lira lost over 69% of its value against USD, can be linked to the gradual and systemic tapering of Fed Rate, from 1.41 in January 2018 to 2.19% in October 2018. The optimized Core Model of ER together with the Integrated Sub-module of DS has provided both novel and simple framework in explaining the advent of the crisis in 2018. The simple model is being expanded in our ongoing research, as we had pointed it out earlier.

The inclusion of policy rate in the Sub-module of DS also reveals interesting results. An increase in policy rates from 25 to 30 (Scenario 1) helps short-term FX flows to increase and in the appreciation of exchange rate. In the absence of availability of reserves, central bank may only resort to use its policy rates to restore financial stability. Such responses, however, can at times be pro-cyclical and may come at the expense of macroeconomic stability.

In Figure 5, we show the results of two additional scenarios of reversals of capital flows that may result due to an external event of significance. In scenario 1 and 2, there is a monthly reversal of 1 and 1.5 billion USD from the stocks, respectively. A 1.5 billion USD reversal shows notable depreciation of Turkish Lira against USD[7].

[7] With stocks of FX liabilities of DS over 130 billion USD, monthly reversals of 1.5 billion USD can occur with changing sentiments of non-resident investors.

Figure 4. Fed Rate and Policy Rate Scenarios and Results.

a) Fed Rate Scenarios. **b) Policy Rate Scenarios.**

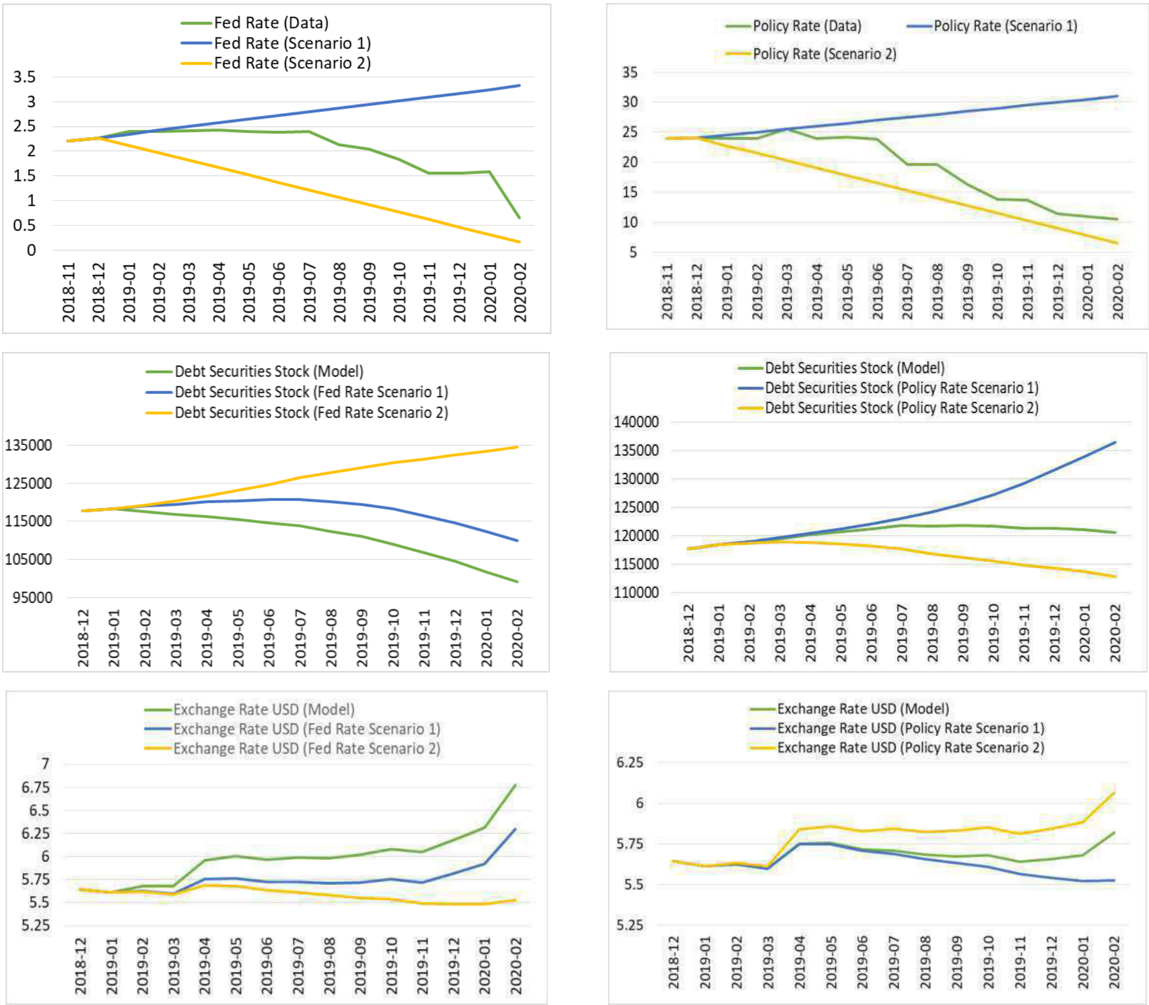
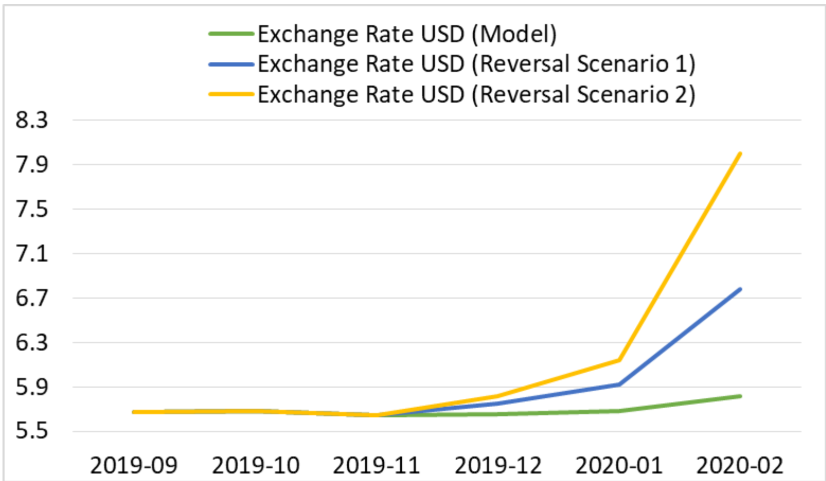


Figure 5. Reversals Scenarios.



4. Conclusion

In this paper, we report simulation results of a partially integrated SD model to explain the short-term fluctuations in exchange rates, based on FX international imbalances reported in the balance of payments. In this paper we only reported the preliminary findings of the Core Model of ER. The results clearly demonstrate that the recent episodes of excessive depreciation of Turkish Lira against USD can be explained by the reversals from stocks of FX liabilities related to debt securities. The model also links the dynamics of these stocks to external factors, such as, Fed Rate and VIX. Several scenario analyses have been carried out to show that short-term financial stability can be linked to these external factors. We also show that changes in Policy Rates of CBRT can be employed to address financial stability but this can be pro-cyclical. The results of our ongoing work that expands the Core model presented in this paper, have further reinforced the preliminary findings reported in this work. We again find strong evidence of linkages between reversals of short-term stocks of liabilities and nominal exchange rates. We have also found that external factors, such as Fed rates, may influence policy rates of the central bank of Turkey to address financial stability concerns that can at times be pro-cyclical.

References

Ahmed, S. and Zlate, S. (2014). "Capital flows to emerging market economies: A brave new world?" *Journal of International Money and Finance,* **48,** 221-248. doi:https://doi.org/10.1016/j.jimonfin.2014.05.015.

IMF (1996). *Balance of Payments Textbook.* Washington, DC: IMF.

IMF (2009). Balance of Payments and International Investment Position Manual. Washington, DC: IMF.

Mano, R., and Sgherri, M. S. (2020). "One shock, many policy responses." IMF Working Paper 20/10.

Mundell, R. A. (1963). "Capital mobility and stabilization policy under fixed and flexible exchange rates." *Canadian Journal of Economics and Political Science,* **29(4),** 475-485. doi:https://doi.org/10.2307/139336.

Obstfeld, M., Ostry, J. D., and Qureshi, M. S. (2019). "A tie that binds: Revisiting the trilemma in emerging market economies." *Review of Economics and Statistics,* **101(2),** 279-293. doi:https://doi.org/10.1162/rest_a_00740.

Rey, H. (2016). "International channels of transmission of monetary policy and the Mundellian trilemma." *IMF Economic Review,* **64(1),** 6-35. doi:https://doi.org/10.1057/imfer.2016.4.

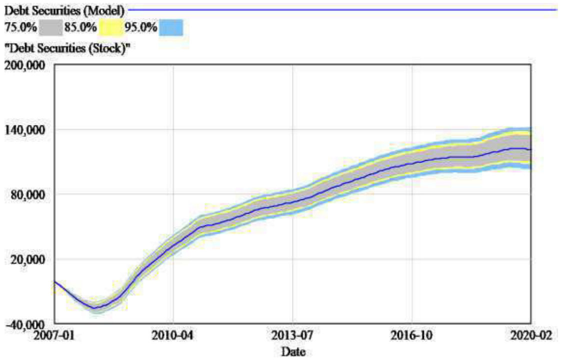
Vassiliadis, V. S., and Conejeros, R. (2008). "Powell Method." In *Encyclopedia of Optimization,* edited by C. A. Floudas and P. M. Pardalos, Vol. 2, 3012–3013. New York: Springer Verlag.

Yamaguchi, Y., and Yamaguchi, K. (2020). "Modeling Cross-Border Payments and Foreign Exchange Dynamics." In *The 2020 Conference of the System Dynamics Society University of Bergen*, July 20-24.

Appendix

Figure A1. Sensitivity Analysis Plots for Optimized Coefficients with ±5% Deviation.

a) **Debt Securities (Stock).**



b) **Exchange Rate.**