

**GALATASARAY UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS**

**EFFECTS OF FINANCIAL DOLLARIZATION ON THE
IMPACT OF INTEREST RATE SHOCK:
A NEW KEYNESIAN DSGE MODEL FOR TURKIYE**



MASTER THESIS

Kadriye Nur ARSLAN

Supervisor: Prof. Dr. S. İrem ZEYNELOĞLU

AUGUST 2023

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PREFACE

I would like to express my gratitude and special thanks to Prof. İrem Zeyneloğlu, who spared valuable time for my studies in her busy schedule and guided me during the challenging process. I owe my thanks to the academic staff of Galatasaray University Department of Economics for their valuable contributions and dedication to the education of all attendees of the masters programme. I also would like to thank the institution and its employees for their contribution. I would like to thank my friends for giving me motivation whenever I felt down. I dedicate this thesis to my family, my mother Semanur Arslan, my father Ahmet Arslan, my two sisters Vildan and Hilal who supported and encouraged me continuously during my graduate education.

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ABBREVIATIONS

BRSA: Banking Regulation and Supervision Agency

CAR: Capital Adequacy Ratio

CES: Constant Elasticity of Substitution

CBRT: Central Bank of the Republic of Türkiye

DSGE: Dynamic Stochastic General Equilibrium

GDP: Gross Domestic Product

ILO: International Labor Organization

IMF: International Money Fund

IRF: Impulse Response Function

MoTF: the Ministry of Treasury and Finance

RBC: Real Business Cycle

SPBM: Sequential Portfolio Balance Model

TDO: Takibe Dönüşüm Oranı

TURKSTAT: Turkish Statistical Institute

VAR : Vector Autoregressive Model

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ABSTRACT

The aim of this thesis is to develop a dynamic stochastic general equilibrium (DSGE) model of a small open economy with banking intermediation structure, imperfect capital mobility and financial dollarization in order to see the impact of financial dollarization on the magnitude and scope of an interest rate shock on Turkish economy. Since historical and empirical findings suggest that dollarization may increase vulnerability of both financial and real economy, it is important to assess the effects of shocks that create disturbance in the economy correctly. The findings from this study could provide helpful information for implementing an appropriate and effective policy against shocks with the presence of dollarization in the economy.

Advantages of using DSGE models are mainly models' ability in incorporating micro and macro theories in the model, capturing the interaction between different group of agents' behavior, containing specific stochastic shocks that give rise to economic fluctuations as well as in utilizing with a small set of information. On the other hand, the literature suggests that addition of liability dollarization ameliorates the model fit. To our best knowledge, this thesis is the first one to address the effect of dollarization on the Turkish economy in a DSGE model with an integrated banking sector.

Second section defines dollarization, explains the types of dollarization, indices to use for determining dollarization and also possible causes for the occurrence. The second part gives detailed information on dollarization history of Turkish economy since 1980s. There're generally three types of dollarization, price, transactions and financial dollarization. Financial dollarization can occur in either or both assets and liabilities. Also, dollarization can be complete and partial, according to the frequency of use of the foreign currency.

Turkiye has been subject to dollarization almost since its switch to an open economy with continued efforts for dedollarization, especially during the crisis years of 1994, 2001, and 2022. This section also describes KKH mechanism introduced recently by the Ministry of Treasury and Finance (MoTF) and the Central Bank of Turkish Republic (CBRT) and the burden it brings on the budget.

Literature review provides a comprehensive review of the literature on the topic of dollarization effects in Türkiye, as well as on the literature of macroeconomic models with dollarization feature.

Literature on the topic of dollarization in Türkiye leans heavily on the topic of determinants of dollarization rather than the effects of dollarization in Türkiye. Additionally, existing literature on the effects of dollarization mainly follows the relationship between dollarization and inflation or exchange rate. Majority of these studies imply a causality relationship from dollarization to inflation and to interest rate. There are also studies focusing on the effects of deposit dollarization on banks' performance in Türkiye.

As it is seen, almost all studies on the subject of dollarization in Türkiye work with econometric models and lack in capturing the theoretic relations of macro variables with each other that DSGE models are capable of. Nevertheless there are several examples of incorporating dollarization in an economic model across the world, including dollarization as a liability allocation problem on banks side, households decision as an asset allocation problem. There are also studies on debt dollarization of real sector but these are not covered since the lending in foreign currency has been restricted in December 2018 only except foreign currency income generating entities in Türkiye.

The model is introduced with first order solutions of each agents' problem in detail in the fourth section. The model is a small open economy with a representative household, intermediate good producing firms, a final good and a capital good producer, a representative bank, the central bank as the regulator of monetary policy and the government included as economic actors. It is assumed that all actors are homogeneous and make rational decisions.

The representative household provides labor supply and receives wage in return, chooses optimal consumption and allocates his deposits into domestic or foreign currency accounts. The capital producer adds the investment goods it purchases to their existing capital stock and provides them to intermediate goods producers as new capital in return for rent. The bank, on the other hand, lends the funds obtained through foreign lending and deposits to firms. The final goods producer buys a bundle of goods from the intermediate goods producer firms and a bundle of the imported intermediate goods from the rest of the world and produces the final product for domestic consumption and export. Intermediate goods producer firms each produce a differentiated good with purchased labor and capital. Price changes of the intermediate goods are costly, adding friction and monopolistic competition conditions in the intermediate goods market. Central Bank also lends to the Bank and regulates the financial system through monetary policy, required reserves and foreign reserves. The government consumes public goods, receives lump-sum tax from households and issues nominal riskless one-period bonds.

Next section describes details of the general equilibrium conditions and steady state of the economy is in before the shock is given. Although it depends on the characteristics of the economy, generally in a DSGE model, the equilibrium consists of a series of fixed prices and allocations that are formed in line with the optimization decisions taken by the economic agents under the market structure and resource constraints. In general equilibrium, the intermediate goods produced by the firms are identical and the market clearing conditions hold for final goods, intermediate goods, labor, capital, money markets. The balance of payments also balances.

Steady state of the economy in when variables become stagnant across periods such as inflation variables become zero with no change in prices between periods. The

steady state values of all variables must be described in the model in order to analyze the deviations of an economy from the steady state when an exogenous shock takes place. The steady state values of the variables are given in Appendix A of the thesis.

Determining values of the parameters used in equations that describe the economy is important in obtaining results that accurately demonstrate the behaviour of the economy modeled. There are two methods used in determining the value of the parameters; estimation and calibration. In calibration method, values are determined based on observations from historical data as well as using established knowledge from previous literature. Convenience of abundant information from previous studies has led to using calibration for parametrizing the model in this study. Calibration section explains the parametrization methods used in the literature and then presents the calibration of the parameters with detailed information on how the calibration was made and which information was used.

In order to measure the response of the economy to external shocks, the foreign interest rate increases with a positive interest rate shock of 1 % quarterly given to the worldwide risk free interest rate in section seven of this thesis.

At the time of the impact, banks' borrowing from the abroad increases as it is dependent on the lending demand of the private sector and the exchange rate. On the other hand, Central Bank increases its foreign reserves in order to maintain the external budget of the economy with increased level of foreign borrowing resulting in increase of the exchange rate. Effect of domestic currency devaluation is immediately seen on both export prices and import prices; Increase in import price raises the general price for final production which in turn leads to inflation. Households change their consumption habits and reduce consumption as a result. The results also show increase in employment with increase in both labor supply and demand in labor and increase in real wages with increase in the policy rate. The impact also causes drop in total output as foreign intermediate goods demand decreases with increase in price of imported goods.

In order to assess the effect of deposit dollarization on the economy, the share of foreign currency deposits in total deposits is calibrated as 0% i.e. and later as 80%. When comparing the results, it is seen that behavior of the economy is generally similar in differing dollarization ratios with the benchmark experiment; output, investment and consumption decrease, meanwhile exchange rate, exports, employment and real wages increase on impact. Still, degree of change is different for some of the key variables of the economy. Increase in exchange rate in particular is suppressed as Central Bank's demand for foreign reserve is diminished. The result of this experiment suggests that with high levels of deposit dollarization, effect of the interest rate increase is mitigated.

Finally, sensitivity of the previous results are assessed with a sensitivity analysis in which the parameter that captures the extent to which the Central Bank determines foreign reserve target in response to amount of imported goods is set to 4 from 2. With increased target reserves, Central Bank has more reserves at steady state. Thus, increase in Central Bank's demand for reserves to maintain its external budget of the economy is less severe on impact which in turn softens the increase in exchange rate. Hence the initial drop in consumption is larger than in the benchmark experiment with the weakened wealth effect stemming from holding foreign currency deposits. Increase in foreign reserves expands monetary base and bond rates drop more, dampening the rise in rental rate of capital and hence inversely mitigating the drop in marginal product of labor and in gross wages. Thus rise in the intermediate good production seen in the benchmark case is diminished as well, which in turn mitigates the production of final good compared to the benchmark experiment. This leads to shortage of supply induced inflation in domestically sold products by more than the benchmark experiment.

The effects of the worldwide riskless interest rate increase on all of the variables in the economy with benchmark case, with different dollarization rates and with sensitivity analysis are explained fully in this section.

In conclusion, a detailed analysis of the results is presented. Initial results show that a positive shock in worldwide interest rate results in a fall in household's consumption, with rising inflation triggered by a raise in exchange rate induced from excess demand of foreign reserves. Furthermore, a fall in intermediate good import

also generated from the raise in exchange rate causes a reduction in the aggregate output and investment but a rise in real wages and employment with increase in intermediate goods producers' productivity.

In order to catch the effect of deposit dollarization on economy, we compared the results of the same positive worldwide interest rate shock between a 0% and 80% deposit dollarization rate of the economy. We found out that the changes in the economy is mitigated as deposit dollarization of households increase. The results may be due to domestic lenders protecting themselves by denominating contracts in a more stable currency and hence decreasing the vulnerability of the economy in some part.

Results of this study shows that deposit dollarization has positive effect on total production, a sign that could be interpreted as the economy doing well, but it also shows negative effect on employment and real wages. This means that even though the wealth effect of keeping deposit in foreign currency in case of an increase in exchange rate boosts the economic activity or mitigates the contraction of the economic activity as in our case, employment and real wages are negatively effected which may disturb social welfare.

Last but not least, we measured the sensitivity of the previous results by alternating the value of the coefficient of imported goods in Central Bank's target foreign reserve, as it is set to 4 from 2. The results imply that effects of worldwide interest rate shock do not change qualitatively when the calibrated value is changed implying the robustness of the model.

The limitations of the study are also explained in this section. Model can be improved to include economic and financial features specific to Türkiye such as addition of direct import of final goods from overseas or model could be more ramified with differentiating economic agents by their activities. Parametrization of the model with estimation techniques may have also given more consistent results. Future research may improve the model, providing a more comprehensive understanding of the dynamics of dollarization and efficient use of information in policy making.

References section is a very important component of the thesis that provides a comprehensive list of all sources, publications and studies cited throughout the study. The references section is required to acknowledge the contributions of other researchers and resources, to demonstrate the completeness of the study, and to allow readers access to the materials cited for further study and validation.

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ÖZET

Bu tezin amacı, bankacılık aracılık yapısını, kusurlu sermaye hareketliliğini ve finansal dolarizasyonu içeren bir dinamik stokastik genel denge (DSGE) modeli oluşturarak, finansal dolarizasyonun faiz şoklarının büyüklüğü ve etkisini analiz etmektir. Türkiye ekonomisine yönelik bu çalışma, finansal ve reel ekonominin dolarizasyon nedeniyle artan kırılganlıklarına işaret eden tarihî ve ampirik bulguların ışığında, ekonomide meydana gelen şokların etkilerini doğru bir şekilde değerlendirmenin önemini vurgulamaktadır. Bu çalışmanın sonuçlarının, ekonomide dolarizasyonun neden olduğu şoklara karşı uygun ve etkili politika tedbirlerinin geliştirilmesine yardımcı olabileceği düşünülmektedir.

DSGE modellerini kullanmanın avantajları, mikro ve makro teorilerin modelde birleştirilmesi, farklı aktör gruplarının etkileşiminin yakalanması, ekonomik dalgalanmaların temelinde yatan stokastik şokların modele dahil edilmesi ve sınırlı bilgi setleriyle çalışabilme yeteneği olarak sıralanabilir. Ayrıca literatür, yükümlülük dolarizasyonunun model uyumunu artırıcı etkisine dikkat çekmektedir. Bilgimize göre, bu tez, Türkiye ekonomisinin bir DSGE modeli içerisinde finansal dolarizasyon etkilerini ele alan ve entegre bir bankacılık sektörünü içeren ilk çalışmadır.

Tezin ikinci bölümünde dolarizasyon tanımlanmakta, dolarizasyonun türleri, dolarizasyonun belirlenmesinde kullanılan göstergeler ve olası sebepleri açıklanmaktadır. İkinci kısmında ise Türkiye ekonomisinin 1980'lerden günümüze dolarizasyon tarihine ilişkin detaylı bilgiler sunulmaktadır. Genellikle üç tür dolarizasyon bulunmaktadır: fiyat dolarizasyonu, işlem dolarizasyonu ve finansal dolarizasyon. Finansal dolarizasyon ise varlıklarda veya yükümlülüklerde veya her ikisinde birden ortaya çıkabilir. Ayrıca dolarizasyon, yabancı para biriminin kullanım sıklığına bağlı olarak tam veya kısmi olarak gerçekleşebilir.

Türkiye, özellikle 1994, 2001 ve 2022 kriz yıllarında dolarizasyonun etkilerine karşı devam eden mücadelesiyle neredeyse açık ekonomiye geçişinden bu yana dolarizasyonla mücadele etmektedir. Bu bölüm ayrıca Türkiye Cumhuriyet Merkez Bankası'nın (TCMB) bu konuda aldığı son tedbirler ve bunların bütçeye etkileri hakkında da bilgi vermektedir.

Literatür incelemesi bölümü, Türkiye'deki dolarizasyonun etkileri hakkındaki literatürü ve dolarizasyon özelliklerine sahip makroekonomik modellerle ilgili literatürü kapsamlı bir şekilde incelemektedir. Türkiye'deki dolarizasyon konusundaki literatürün çoğunluğu, dolarizasyonun etkilerine daha çok odaklanmaktansa, dolarizasyonun belirleyicilerine odaklanmaktadır. Ayrıca, dolarizasyonun etkilerine dair mevcut literatür, genellikle dolarizasyon ile enflasyon veya döviz kuru arasındaki ilişkiyi incelemektedir. Bu çalışmaların büyük bir kısmı, dolarizasyondan enflasyona ve faiz oranına doğru bir nedensellik ilişkisi olduğunu göstermektedir. Ayrıca Türkiye'de, mevduat dolarizasyonunun banka performansı üzerindeki etkilerini inceleyen çalışmalar da bulunmaktadır.

Türkiye'de yapılan çalışmaların büyük bir kısmı ekonometrik modellerle gerçekleştirilmekte olup, makroekonomik değişkenler arasındaki teorik ilişkileri DSGE modelleri kadar iyi yakalayamamaktadır. Ancak dünya genelinde, dolarizasyonun ekonomik modellere dahil edilmesine yönelik birkaç örnek bulunmaktadır. Bu örnekler arasında bankaların borç tahsis sorunu olarak dolarizasyon ve hanehalkının varlık tahsis sorunu olarak dolarizasyon bulunmaktadır. Reel sektörün döviz cinsinden borçlanmasını inceleyen çalışmalar da mevcuttur, ancak 2018 yılında Türkiye'de döviz cinsinden borç verilmesi kısıtlanmış olduğundan bu tür çalışmalar genellikle Türkiye'de döviz geliri sağlayan kuruluşları içermektedir.

Dördüncü bölümde, tüm ekonomik birimlerin optimizasyon problemine ait birinci dereceden çözümlerle model detaylı bir şekilde tanıtılmıştır. Model, bir temsilci hanehalkı, ara mal üreten firmalar, bir nihai mal ve sermaye malı üreticisi, temsilci bir banka, para politikası düzenleyicisi olarak merkez bankası ve ekonomik aktörler olarak hükümetin dahil olduğu küçük bir açık ekonomiyi kapsamaktadır. Tüm aktörlerin homojen olduğu ve rasyonel kararlar aldığı varsayılmıştır.

Temsilci hanehalkı, emek arzı sağlar ve bunun karşılığında ücret alır. Ayrıca, optimal tüketimini seçer ve mevduatını yerel veya yabancı para hesaplarına tahsis eder. Sermaye üreticisi, satın aldığı yatırım mallarını mevcut sermaye stokuna ekleyerek ara mal üreticilerine yeni sermaye sağlar. Banka, yurt dışından ödünç verme ve mevduat yoluyla elde ettiği fonları firmalara borç olarak sağlar. Nihai mal üreticisi, ara malı üreticisi firmalardan bir paket mal ve dünyanın geri kalanından ithal edilen ara mallardan bir paket satın alır ve nihai ürünü iç tüketim ve ihracat için üretir. Ara malı üreticisi firmalar, satın aldıkları emek ve sermaye ile farklılaşmış bir mal üretir. Ara malı fiyat değişiklikleri maliyetlidir ve ara malı piyasasında sürtüşme ve tekelci rekabet koşullarını yaratır. Merkez Bankası, Banka'ya borç verir ve para politikasını zorunlu karşılıklar ve döviz rezervleri aracılığıyla düzenler. Devlet, kamu mallarını tüketir, hanehalkından toplam vergi alır ve nominal risk içermeyen kısa vadeli tahviller çıkarır.

Tezin beşinci bölümünde, bir şok uygulanmadan önce ekonominin genel denge koşulları ve durağan durumu ayrıntılı bir şekilde açıklanmaktadır. Ekonominin özelliklerine bağlı olarak, bir DSGE modelinde denge, piyasa yapısı ve kaynak kısıtları altında ekonomik birimlerin optimizasyon kararlarına dayalı olarak oluşan sabit fiyatlar ve tahsisler dizisinden oluşur. Genel denge durumunda, firmaların ürettiği ara mallar aynıdır ve nihai mallar, ara mallar, emek, sermaye ve para piyasaları için piyasa takas koşulları geçerlidir. Genel denge durumunda ödemeler dengesi de ayrıca sağlanır.

Ekonominin durağan durumu, değişkenlerin dönemler boyunca değişmeksizin sabit değerlere sahip olduğu durumdur. Örneğin, enflasyon gibi değişkenlerin dönemler arasında herhangi bir fiyat değişikliği olmadan sıfır olduğu durumdur. Bir dışsal şok meydana geldiğinde, ekonominin durağan durumdan sapmalarını analiz etmek için tüm değişkenlerin kararlı durum değerleri modelde açıklanmalıdır. Değişkenlerin kararlı durum değerleri, tezin Ek A bölümünde verilmiştir.

Ekonomiyi tanımlayan denklemlerde kullanılan parametrelerin değerlerinin belirlenmesi, modellenen ekonominin davranışını doğru bir şekilde ortaya koymak açısından önemlidir. Parametre değerlerinin belirlenmesinde kullanılan iki yöntem vardır: tahmin ve kalibrasyon. Kalibrasyon yönteminde, değerler geçmiş verilerden

elde edilen gözlemlere ve önceki literatürden elde edilen yerleşik bilgilere dayanarak belirlenir. Önceki çalışmalardan elde edilen bol miktarda bilginin uygunluğu, bu çalışmada modelin parametrik yapısının kalibrasyon kullanılmasına yol açmıştır. Kalibrasyon bölümünde, literatürde kullanılan parametrelendirme yöntemleri açıklanmakta ve ardından kalibrasyonun nasıl yapıldığı ve hangi bilgilerin kullanıldığına dair detaylı bilgilerle parametrelerin kalibrasyonu sunulmaktadır.

Ekonominin dış şoklara tepkisini ölçmek amacıyla tezin yedinci bölümünde yurtdışı risksiz faiz oranının verildiği durumda, yabancı faiz oranının üç aylık bir dönemde %1 pozitif faiz şoku ile arttığı gözlemlenmektedir.

Bu etki anında özel sektörün borç verme talebine ve döviz kuru üzerine etki etmektedir. Bankalar yurt dışından daha fazla borçlanmaktadır, ancak döviz kuru yükselirken dış borç düzeyi de artmaktadır, bu da Merkez Bankası'nın döviz rezervlerini koruma amacıyla müdahale etmesine neden olur. Yerli para birimi değer kaybının etkisi hızla ihracat ve ithalat fiyatlarını etkilemekte; ithalat fiyatlarının yükselmesi genel fiyat seviyelerini yükseltmekte ve bunun sonucunda enflasyon artmaktadır. Hanehalkı bu durumda tüketim alışkanlıklarını değiştirir ve tüketimi azaltır. Sonuçlar aynı zamanda istihdamın arttığını ve politika faizinin yükselmesiyle reel ücretlerin arttığını göstermektedir. Ayrıca, yabancı ara malı talebinin azalması nedeniyle ithal mal fiyatları artmakta ve bu da toplam çıktıda düşüşe yol açmaktadır.

Mevduat dolarizasyonunun ekonomiye etkisini değerlendirmek için yabancı para cinsinden mevduatın toplam mevduat içindeki payı önce %0 ve daha sonra %80 olarak kalibre edilmiştir. Sonuçlar karşılaştırıldığında, farklı dolarizasyon oranlarıyla ekonominin davranışının benzer olduğu görülmektedir; çıktı, yatırım ve tüketim azalırken, döviz kuru, ihracat, istihdam ve reel ücretler artmaktadır. Ancak bazı temel değişkenlerde farklılıklar da görülmektedir. Özellikle döviz kuru artışı, Merkez Bankası'nın döviz rezerv talebinin etkisini zayıflatır. Bu deneyin sonucu, yüksek mevduat dolarizasyonunun faiz artışının etkisini hafiflettiğini göstermektedir.

Son olarak, önceki sonuçların duyarlılığı, Merkez Bankası'nın ithal mal miktarına karşılık döviz rezerv hedefi belirleme derecesini yansıtan parametrenin

değeri değiştirilerek analiz edilir. Bu durumda Merkez Bankası daha fazla rezerve sahiptir. Bu da döviz kuru artışını sınırlayarak tüketimdeki düşüşü etkiler. Bu deneyde, yabancı para cinsinden mevduat tutmanın zayıflamış servet etkisi daha büyük olduğundan, tüketimdeki düşüş daha belirgin olabilir. Döviz rezervlerindeki artış, para tabanını genişletir ve tahvil faizlerini düşürürken sermayenin kira oranındaki artışı azaltır. Sonuç olarak, ara malı üretimindeki artış da azalır ve nihai ürünün üretimi kıyaslama deneyine göre daha az etkilenir. Bu durum, yurtiçinde satılan ürünlerde arz kaynaklı enflasyonun daha fazla artmasına neden olabilir.

Dünya çapındaki risksiz faiz artışının ekonomideki tüm değişkenler üzerindeki etkileri, farklı dolarizasyon oranları ve duyarlılık analizleriyle bu bölümde ayrıntılı olarak açıklanmıştır.

Sonuç bölümünde, sonuçların ayrıntılı bir analizi sunulmaktadır. İlk sonuçlar, dünya çapındaki faiz oranındaki pozitif bir şokun hanehalkı tüketiminde düşüşe neden olduğunu ve aşırı döviz talebi tarafından tetiklenen yükselen enflasyona yol açtığını göstermektedir. Ayrıca, döviz kurundaki artışın, ara malı ithalatında düşüşe neden olduğu, bu da toplam üretim ve yatırımda azalmaya, ara malı üreticilerinin verimliliğindeki artışla birlikte reel ücretlerde ve istihdamda artışa neden olduğu görülmektedir.

Mevduat dolarizasyonunun ekonomi üzerindeki etkisini yakalamak için, ekonominin %0 ile %80 mevduat dolarizasyon oranı arasında aynı pozitif faiz şokunun sonuçlarını karşılaştırdık. Hanehalkının mevduat dolarizasyonu arttıkça ekonomideki değişimlerin azaldığını gözlemledik. Sonuçlar, yerel borç verenlerin sözleşmeleri daha istikrarlı bir para biriminde belirleyerek kendilerini korumaları ve dolayısıyla ekonominin kırılganlığını bir ölçüde azaltmasından kaynaklanıyor olabilir.

Bu çalışmanın sonuçları, mevduat dolarizasyonunun toplam üretim üzerinde olumlu bir etkiye sahip olduğunu ve bu ekonominin iyileşme işareti olabileceğini, ancak istihdam ve reel ücretler üzerinde olumsuz bir etki gösterdiğini göstermektedir. Bu da, döviz kurunun yükselmesi durumunda döviz cinsinden mevduat tutmanın servet etkisi, bizim durumumuzda olduğu gibi ekonomik aktiviteyi artırsa veya

ekonomik aktivitedeki daralmayı hafifletse de, istihdam ve reel ücretlerin olumsuz etkilenecek sosyal rahatsızlıklara neden olabileceğini göstermektedir.

Son olarak, önceki sonuçların duyarlılığını test etmek için Merkez Bankası'nın hedef döviz rezervindeki ithal mal katsayısını 2'den 4'e değiştirerek ölçtük. Elde edilen sonuçlar, dünya genelindeki faiz oranı şokunun etkilerinin kalibrasyon değeri değiştirildiğinde niteliksel olarak aynı kaldığını göstermektedir. Bu durum, modelin sağlamlığını işaret etmektedir.

Araştırmanın sınırlılıkları da bu bölümde açıklanmıştır. Model, yurt dışından doğrudan nihai mal ithalatı gibi Türkiye'ye özgü ekonomik ve finansal özellikleri içerecek şekilde geliştirilebilir veya ekonomik birimlerin faaliyetlerine göre farklılaştırılarak model daha da dallandırılabilir. Ayrıca, tahmin teknikleriyle modelin parametrizasyonunun daha tutarlı sonuçlar vermesi mümkün olabilir. Gelecekteki araştırmalar, dolarizasyon dinamiklerinin daha kapsamlı bir şekilde anlaşılmasını sağlayarak modelin geliştirilmesi ve politika yapımında bilginin daha verimli bir şekilde kullanılmasını hedefleyebilir.

Referanslar bölümü, çalışma boyunca atıfta bulunulan tüm kaynakların, yayınların ve çalışmaların kapsamlı bir listesini sunan tezin çok önemli bir bileşenidir. Referanslar bölümü, diğer araştırmacıların ve kaynakların katkılarını kabul etmek, çalışmanın eksiksiz olduğunu göstermek ve okuyucuların daha fazla çalışma ve doğrulama için belirtilen materyallere erişmesine izin vermek için gereklidir.

RÉSUMÉ

L'objectif de cette thèse est de développer un modèle dynamique d'équilibre général stochastique (DSGE) pour une petite économie ouverte, en intégrant une structure d'intermédiation bancaire, une mobilité imparfaite du capital et une dollarisation financière. L'objectif est d'analyser l'impact de la dollarisation financière sur l'amplitude et l'étendue d'un choc de taux d'intérêt dans l'économie turque. Étant donné que les résultats historiques et empiriques suggèrent que la dollarisation peut accroître la vulnérabilité de l'économie financière et réelle, il est essentiel d'évaluer correctement les effets des chocs qui perturbent l'économie. Les résultats de cette étude pourraient fournir des informations précieuses pour l'élaboration de politiques adéquates et efficaces en présence de la dollarisation dans l'économie.

Les avantages d'utiliser des modèles DSGE résident principalement dans leur capacité à intégrer des théories micro et macroéconomiques, à saisir les interactions entre les comportements de différents groupes d'agents, à incorporer des chocs stochastiques spécifiques entraînant des fluctuations économiques, ainsi qu'à fonctionner avec un ensemble limité d'informations. D'autre part, la littérature suggère que l'ajout de la dollarisation du passif améliore l'ajustement du modèle. À notre connaissance, cette thèse est la première à examiner l'effet de la dollarisation sur l'économie turque en utilisant un modèle DSGE qui intègre un secteur bancaire.

Le deuxième section définit la dollarisation, explique les différents types de dollarisation, les indicateurs utilisés pour mesurer la dollarisation et les causes possibles de son occurrence. La deuxième partie fournit des informations détaillées sur l'évolution de la dollarisation dans l'économie turque depuis les années 1980. En général, il existe trois types de dollarisation : la dollarisation des prix, des transactions et financière. La dollarisation financière peut concerner les actifs, les passifs, voire les

deux. De plus, la dollarisation peut être complète ou partielle, en fonction de la fréquence d'utilisation de la devise étrangère.

La Turquie a été confrontée à la dollarisation pratiquement depuis sa transition vers une économie ouverte, malgré des efforts continus de dédollarisation, notamment au cours des périodes de crise en 1994, 2001 et 2022. Cette section décrit également le mécanisme KKH récemment introduit par le ministère du Trésor et des Finances (MoTF) ainsi que par la Banque centrale de la République turque (CBRT), et expose le fardeau qu'il implique pour le budget.

Revue de La Littérature offre une revue exhaustive de la littérature sur les effets de la dollarisation en Turquie, ainsi que sur la littérature des modèles macroéconomiques incluant la caractéristique de dollarisation.

La littérature concernant la dollarisation en Turquie se focalise principalement sur les déterminants de la dollarisation plutôt que sur ses effets. De plus, les études existantes sur les effets de la dollarisation se concentrent principalement sur la relation entre la dollarisation, l'inflation et le taux de change. La plupart de ces études suggèrent une relation de causalité entre la dollarisation, l'inflation et les taux d'intérêt. Il existe également des recherches examinant les répercussions de la dollarisation des dépôts sur la performance des banques en Turquie.

Il est important de noter que la plupart des études sur la dollarisation en Turquie reposent sur des modèles économétriques et n'explorent pas les relations théoriques entre les principales variables macroéconomiques, que les modèles DSGE sont capables de capturer. Néanmoins, il existe divers exemples d'intégration de la dollarisation dans des modèles économiques à travers le monde, abordant des aspects tels que la dollarisation en tant que problème d'allocation du passif du côté des banques, la prise de décision des ménages en tant que problème d'allocation d'actifs, voire la dollarisation de la dette du secteur réel. Cependant, les prêts en devises étrangères ont été restreints en décembre 2018, à l'exception des entités génératrices de revenus en devises étrangères en Turquie, ce qui a limité les études sur la dollarisation de la dette du secteur réel.

Le modèle est présenté en détail avec les solutions de premier ordre pour le problème de chaque agent dans la quatrième section. Il s'agit d'une petite économie ouverte comprenant un ménage représentatif, des entreprises productrices de biens intermédiaires, un producteur de biens finaux et de biens d'équipement, une banque représentative, la banque centrale en tant que régulateur de la politique monétaire, et le gouvernement inclus en tant qu'acteurs économiques. On suppose que tous les acteurs sont homogènes et prennent des décisions rationnelles.

Le ménage représentatif fournit une offre de travail et reçoit un salaire en échange. Il choisit une consommation optimale et répartit ses dépôts entre des comptes en monnaie nationale ou étrangère. Le producteur de biens d'équipement ajoute les biens d'investissement qu'il achète à son stock de capital existant et les fournit aux producteurs de biens intermédiaires en tant que nouveau capital, en échange d'une rente. La banque prête les fonds obtenus grâce aux prêts et dépôts étrangers aux entreprises. Le producteur de biens finaux achète à la fois des biens auprès des entreprises productrices de biens intermédiaires et des biens intermédiaires importés du reste du monde, et produit le produit final pour la consommation intérieure et l'exportation. Les entreprises productrices de biens intermédiaires fabriquent des biens différenciés en utilisant le travail et le capital achetés. Les variations de prix des biens intermédiaires sont coûteuses, introduisant des frictions et des conditions de concurrence monopolistique sur le marché des biens intermédiaires. La Banque centrale prête également à la banque et régule le système financier par le biais de la politique monétaire, des réserves obligatoires et des réserves de change. Le gouvernement consomme des biens publics, perçoit un impôt forfaitaire des ménages et émet des obligations nominales sans risque à une période.

La section équilibre général et état d'équilibre décrit en détail les conditions d'équilibre général et l'état d'équilibre de l'économie avant que le choc ne soit appliqué. Bien qu'il dépende des caractéristiques spécifiques de l'économie, généralement dans un modèle DSGE, l'équilibre se caractérise par une série de prix et d'allocations fixes qui se forment en fonction des décisions d'optimisation prises par les agents économiques, tout en tenant compte de la structure du marché et des contraintes de ressources. En équilibre général, les biens intermédiaires produits par les entreprises sont identiques, et les conditions d'équilibre du marché sont satisfaites pour les biens

finaux, les biens intermédiaires, le travail, le capital et les marchés monétaires. De plus, la balance des paiements est également équilibrée.

L'état stable de l'économie est atteint lorsque les variables stagnent d'une période à l'autre, telles que les variables d'inflation devenant nulles sans qu'il y ait de changement de prix entre les périodes. Les valeurs à l'état d'équilibre de toutes les variables doivent être définies dans le modèle afin d'analyser les écarts d'une économie par rapport à l'état d'équilibre lorsqu'un choc exogène survient. Les valeurs en régime permanent des variables sont fournies dans l'annexe A de la thèse.

La détermination des valeurs des paramètres utilisés dans les équations qui décrivent l'économie est essentielle pour obtenir des résultats précis reflétant le comportement de l'économie modélisée. Deux méthodes sont couramment utilisées pour déterminer les valeurs des paramètres: l'estimation et le calibrage. Dans la méthode du calibrage, les valeurs sont définies en se basant sur des observations à partir de données historiques ainsi que sur les connaissances établies dans la littérature antérieure. L'abondance d'informations provenant d'études antérieures a conduit à l'utilisation du calibrage pour paramétrer le modèle dans cette étude. La section calibrage explique les méthodes de paramétrisation qui ont été utilisées dans la littérature, puis présente le calibrage des paramètres avec des informations détaillées sur la manière dont le processus de calibrage a été réalisé et quelles informations ont été prises en compte.

Pour évaluer la réaction de l'économie aux chocs externes, nous augmentons le taux d'intérêt étranger par un choc positif de 1 % par trimestre dans la section septième.

Au moment de l'impact, les emprunts des banques à l'étranger augmentent en réponse à la demande de prêts du secteur privé et au taux de change. Parallèlement, la Banque centrale accroît ses réserves de change pour équilibrer le budget extérieur de l'économie avec un niveau accru d'emprunts étrangers, ce qui entraîne une hausse du taux de change. La dévaluation de la monnaie nationale se traduit immédiatement par des effets perceptibles tant sur les prix à l'exportation que sur les prix à l'importation. L'augmentation du prix à l'importation entraîne une hausse générale des prix des

produits finaux, provoquant ainsi une inflation. Les ménages modifient leurs habitudes de consommation en conséquence, ce qui conduit à une réduction de la consommation. Les résultats mettent également en évidence une augmentation de l'emploi due à une hausse de l'offre et de la demande de main-d'œuvre, ainsi qu'une augmentation des salaires réels due à une hausse du taux directeur. L'impact se traduit également par une diminution de la production totale à mesure que la demande étrangère de biens intermédiaires diminue avec l'augmentation du prix des biens importés.

Afin d'évaluer l'effet de la dollarisation des dépôts sur l'économie, nous calibrons la part des dépôts en devises dans le total des dépôts à 0 %, puis plus tard à 80 %. En comparant les résultats, nous constatons que le comportement de l'économie est généralement similaire pour différents niveaux de dollarisation par rapport à l'expérience de référence. La production, l'investissement et la consommation diminuent, tandis que le taux de change, les exportations, l'emploi et les salaires réels augmentent au moment de l'impact. Cependant, le degré de changement varie pour certaines variables clés de l'économie. L'augmentation du taux de change en particulier est moins prononcée, car la demande de la Banque centrale pour les réserves de change est réduite. Ces résultats suggèrent qu'avec des niveaux élevés de dollarisation des dépôts, l'effet de la hausse des taux d'intérêt est atténué.

Enfin, nous évaluons la sensibilité des résultats précédents à l'aide d'une analyse de sensibilité où le paramètre reflétant la manière dont la Banque centrale détermine l'objectif de réserve de change en fonction du montant des biens importés est fixé à 4 au lieu de 2. Avec des réserves cibles accrues, la Banque centrale détient davantage de réserves à l'état d'équilibre. Par conséquent, la hausse de la demande de réserves de la Banque centrale pour maintenir l'équilibre du budget extérieur de l'économie a un impact moins sévère, ce qui atténue l'augmentation du taux de change. Ainsi, la baisse initiale de la consommation est plus prononcée par rapport à l'expérience de référence, en affaiblissant l'effet de richesse associé à la détention de dépôts en devises. L'augmentation des réserves de change élargit la base monétaire, ce qui fait davantage baisser les taux d'obligations, atténuant ainsi la hausse du taux d'intérêt du capital, et par conséquent, inversant la baisse du produit marginal du travail et des salaires bruts. Par conséquent, l'augmentation de la production de biens intermédiaires observée dans le cas de référence est également atténuée, ce qui à son tour diminue la production

finale par rapport à l'expérience de référence. Cela entraîne une augmentation limitée de l'inflation due à l'offre de produits vendus sur le marché intérieur par rapport à l'expérience de référence.

Les effets de la hausse mondiale des taux d'intérêt sans risque sur l'ensemble des variables économiques sont expliqués en détail dans cette section, en tenant compte d'un cas de référence ainsi que de différents taux de dollarisation. De plus, une analyse de sensibilité est également présentée.

Dans la conclusion, une analyse détaillée des résultats est présentée. Les premiers résultats montrent qu'un choc positif sur les taux d'intérêt mondiaux se traduit par une baisse de la consommation des ménages, tandis que l'augmentation de l'inflation est déclenchée par une hausse du taux de change induite par une demande excédentaire de réserves de change. De plus, une réduction des importations de biens intermédiaires, également générée par l'augmentation du taux de change, entraîne une diminution de la production et de l'investissement agrégés. Cependant, une augmentation des salaires réels et de l'emploi est observée, résultant d'une augmentation de la productivité des producteurs de biens intermédiaires.

Afin de saisir l'effet de la dollarisation des dépôts sur l'économie, nous avons comparé les résultats du même choc de taux d'intérêt mondial positif entre un taux de dollarisation des dépôts de 0 % et 80 % de l'économie. Nous avons découvert que les changements dans l'économie sont atténués à mesure que la dollarisation des dépôts des ménages augmente. Les résultats peuvent être dus au fait que les prêteurs nationaux se protègent en libellant les contrats dans une devise plus stable, diminuant ainsi la vulnérabilité de l'économie dans une certaine mesure.

Les résultats de cette étude montrent que la dollarisation des dépôts a un effet positif sur la production totale, ce qui pourrait être interprété comme le signe d'une économie en bonne santé. Cependant, elle montre également un effet négatif sur l'emploi et les salaires réels. Cela signifie que même si l'effet de richesse lié au maintien d'un dépôt en devises étrangères en cas d'augmentation du taux de change stimule l'activité économique ou atténue la contraction économique, comme c'est le

cas dans notre situation, l'emploi et les salaires réels sont impactés de manière négative, ce qui peut perturber le bien-être social.

Enfin, nous avons mesuré la sensibilité des résultats précédents en alternant la valeur du coefficient des biens importés dans la réserve de change cible de la Banque centrale, car il est fixé à 4 au lieu de 2. Les résultats impliquent que les effets du choc des taux d'intérêt mondiaux ne changent pas qualitativement lorsque la valeur calibrée est modifiée, ce qui confirme la robustesse du modèle.

Les limites de l'étude sont également expliquées dans cette section. Le modèle pourrait être amélioré pour inclure des caractéristiques économiques et financières spécifiques à la Turquie, telles que l'ajout de l'importation directe de produits finaux de l'étranger, ou le modèle pourrait être plus ramifié en différenciant les agents économiques par leurs activités. La paramétrisation du modèle avec des techniques d'estimation aurait également pu fournir des résultats plus cohérents. Des recherches futures pourraient améliorer le modèle en offrant une compréhension plus complète de la dynamique de la dollarisation et en permettant une utilisation efficace des informations dans l'élaboration des politiques.

Références est un élément très important de la thèse qui fournit une liste complète de toutes les sources, publications et études citées tout au long de l'étude. La section des références est nécessaire pour reconnaître les contributions d'autres chercheurs et ressources, pour démontrer l'exhaustivité de l'étude et pour permettre aux lecteurs d'accéder aux documents cités pour une étude et une validation plus approfondies.

I. INTRODUCTION

Many emerging countries including Türkiye have been facing the consequences of dollarization since the liberalization of their economies in 1980s. Empirical findings suggest that dollarization may increase vulnerability of both financial and real economy by various channels, such as creating currency mismatches in portfolios of banks and non-bank corporations, increasing credit risk with possible deterioration of credit loan portfolio in foreign currency or creating liquidity risk through possible withdraw of foreign denominated liabilities. There are also studies (Oskooee and Domac (2003), Castillo et al (2006)) emphasizing on the positive relationship between the dollarization and inflation. On the contrary, dollarization inducing events such as depreciation of domestic currency is thought to have export incentive features (Karamollaoglu and Yalcin (2020), Akdogan et al (2021)). All the implications considered, the topic of dollarization including the efforts to prevent it has been an important subject for Turkish economy for a long time. The aim of this study is hence to research the effects of deposit dollarization during a plausible shock in the form of interest rate increase in Turkish economy with a New Keynesian DSGE model, one of the most recent tools used for policy analysis and forecasting.

Dynamic Stochastic General Equilibrium (DSGE) models are tools that are used to interpret the movements of macroeconomic time series (GDP, unemployment, consumption, etc.) in the business cycle for a certain period of time and to predict their movements against stochastic shocks by using modern macroeconomic theories, microeconomic principles and the general equilibrium assumptions of the markets. Kydland and Prescott's work on the Real Business Cycle (RBC) models in 1982 is considered to be the origins of the DSGE models. The DSGE model is seen as an expanded and improved version of the RBC model in which money is added to the

economy. New Keynesian economists then changed the assumptions of this model and developed a new type of DSGE model by including the effects of monetary policy and market frictions in the model (Bilir (2021)). One of the advantages of DSGE models is the models' incorporating micro and macro theories in general equilibrium nature, capturing the interaction between different group of agents' behavior. Furthermore, containing spesific stochastic shocks that give rise to economic fluctuations provides the shocks' transmission to the economy to be seen more clearly (Sbordone et al (2010)). In addition, well specified DSGE models can be utilized with a small set of information (Boivin and Giannoni (2006)). These advantages reflect in the forecasting ability of DSGE models that are found to be on par with and even better than time series models (Edge and Gürkaynak (2010)). In the efforts to answer the criticism directed at the New Keynesian DSGE models such as the degree of realism in the assumptions, its lack of ability in measuring welfare, insufficient inclusion of financial frictions in the model, the model is continually evolving (Örün (2020)).

To our best knowledge, this thesis is the first one to address the effect of dollarization on the Turkish economy in a DSGE model with an integrated banking sector. The basis of the New Keynesian DSGE model used in this study is from Agenor et al. (2014) developed for emerging countries. The distinguishing feature of the model is the addition of banking from Agenorsystem as an intermediary in financial sector as in Goodfriend and McCallum (2007); Gerali et al (2010) as addition of financial system to the DSGE framework has gained importance after the financial crisis of 2008. However our model differs from Agenor et al 2014 in several aspects. The main difference is the addition of dollarization as in Ohanyan (2006), a CES type function but with predetermined and fixed deposit dollarization ratios are added as an allocation problem for the representative household. The implementation of the dollarization in the model is through the rationale of Sequential Portfolio Balance Model (SPBM), where agents first decide on the monetary assets to hold, and then divide them in currencies. Turkish data is found to support the SPBM in explaining the relationship between substitution and expectations in exchange rate movements in Baskurt (2005). Adding dolarization in the model is documented to be increasing predictive accuracy of the model as this incorporates an important phenomenon

especially for an emerging economy to the model. Rosenkranz and Notz (2021) and Castillo et al (2006) both found that the accounting for liability dollarization improves the model fit. Adding dollarization enables us to analyze the effects of dollarization on the economy. Furthermore, bank borrowing via bonds from the household was omitted for simplicity reasons since banks borrowing via bonds constitute only 2,3%¹ of total bank liabilities in Türkiye. Omission of bonds issued by the bank moreover led to the omission of the capital requirement imposed on the bank in the model. Also, the model was calibrated exclusively for the Turkish economy and the random shock was added to the model in a way that would provide foreign capital outflow from the country.

The findings of this study about the results of an exogenous monetary shock on the economy with differing financial dollarization rates would have several policy implications. The numerical results from this study are expected to show the level of fragility the economy carries as a result of the deposit dollarization mechanism in Türkiye, which could provide helpful information for implementing an appropriate and effective monetary policy against exogenous shocks with the presence of dollarization in the economy or for preventing dollarization altogether.

This thesis is organized as follows. Section 2 describes dollarization and presents financial dollarization in Türkiye. Section 3 presents the model with a banking system, intermediate goods producers and price rigidity was created and Section 4 analyses general equilibrium and steady state conditions of the economy. In Section 5, calibration of the model is presented. Finally, the results of the analyses with a positive shock applied to the worldwide risk-free interest rate as well as a sensitivity analysis are discussed in Section 6 and Section 7 concludes the study.

¹ March 2023, The Bank Association of Türkiye Statistics

II. FINANCIAL DOLLARIZATION IN TURKIYE

II.A. Definition of Dollarization

Dollarization is basically the use of foreign currency (usually US Dollar) for all or some functions of money instead of the domestic currency in an economy.

There're generally three types of dollarization in the literature. Price dollarization is when the prices are dependent on the exchange rate, and is seen in economies with a high rate of imported commodity and intermediate goods. Transactions dollarization is the case when foreign currency is used as a means of payment. Financial dollarization is the case when foreign currency is preferred as store of value; for either or both assets and liabilities. Also, dollarization can be complete, when foreign currency is a legal tender, and partial, when foreign currency is used along with domestic currency (Urosevic et al, 2014). The focus of this study will be only on partial financial dollarization, where foreign currency becomes the preferred denomination for savings.

Dollarization phenomenon occurs usually in emerging countries, when a country's own currency loses its usefulness as a medium of exchange or as a protection from high inflation or instability.

In the literature, dollarization is often measured as the ratio of foreign currency deposits to either total deposits or the broad money supply (M2Y). However, dollarization is actually considered both in terms of assets and liabilities, thus the definitions of loan and deposit dollarization come forward (Deniz, 2021). Credit dollarization is the ratio of the banking sector's foreign currency loans to either total loans or total assets. On the other hand, deposit dollarization is the ratio of foreign currency deposits of the banking sector to either total deposits or total liabilities. After the exchange rate crisis in Turkiye at the third quarter of 2018, several measures were taken in order to protect the Turkish lira, one of which was restricting the lending in

foreign currency only except foreign currency income generating entities. Credit dollarization and the risks it brings have been thus eliminated to a great extent. For this reason, only deposit dollarization is the main concern in our study.

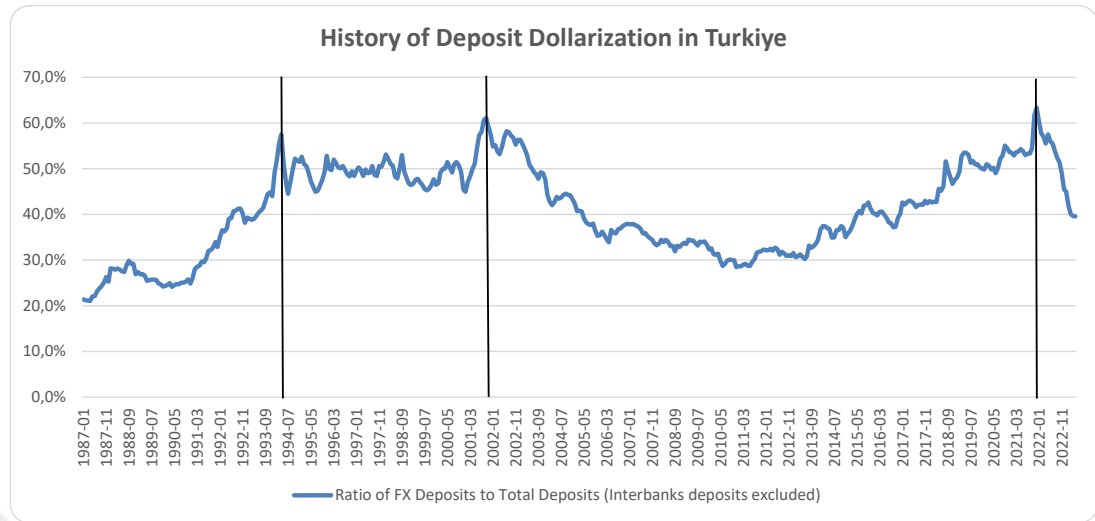
Dollarization may arise from fixed exchange rate regimes, macroeconomic instabilities or high inflation. It is also suggested in studies that, in addition to high inflation and economic instability, institutional factors such as inefficient market regulations and lack of credibility of economic policies also played an important role in the evolution of dollarization in Türkiye (Oskooee and Domac, 2003).

II.B. Dollarization in Turkish Economy

It is believed that dollarization restricts the influence of monetary and exchange rate policies as well as creating inflationary pressures and increasing vulnerability of financial and economic system to exchange rate fluctuations (Urosevic and Rajkovic, 2016). Also the economy is effected by the monetary policy of the country the foreign currency belongs to. Türkiye has been subject to dollarization almost since its switch to an open economy in the 1980s.

Due to the economic crisis arising from the balance of payments and the political problems that followed in the early 1980s in Türkiye, it was decided to take the necessary measures in order to switch to an export based strategy instead of the import substitution industrialization strategy. In addition, a new economic stabilization package was put into effect, including financial reform and liberalization of capital movements. Accordingly, an active exchange rate system was created, with the aim of providing freedom in foreign exchange movements and capital markets. Moreover, the residents of the country were given the possibility to open deposit accounts in foreign exchange. Due to all developments, Turkish lira became convertible by 1985 (Özen, 2018) and from this period on, the extent of dollarization has been observed to be high in Türkiye with rapid increase especially during the crisis years (1994, 2001, 2022).

Figure 1 Deposit Dollarization in Türkiye – Source : CBRT EVDS



Liberalization of the financial system in Türkiye without macroeconomic stability and necessary institutional and structural changes made the Turkish economy more vulnerable to possible shocks in the 1990s (Yilmaz, 2006). High levels of public sector deficits in this period continued as in previous periods, especially soaring after 1989, a period of high interest and high inflation has been entered. A part of the growing budget deficit was financed by the Central Bank, creating inflationary pressure and the remaining through domestic borrowing, increasing the demand for financing and escalating interest rates. Expectations worsened and uncertainty increased due to the failure to implement the right policies to eliminate macroeconomic instability (Keskin et al, 2018) and led the economic actors to gravitate towards currency substitution with inflation reaching three digit values by 1994 (Civcir, 2004).

Build up to the crisis in 2001 was again due to several factors; 1998 Russian economic crisis and increasing public budget deficit with 1999 earthquake and early election which led to contractionary tax enforcement in order to finance the deficit turned expectations negative and drove inflation. IMF standby agreement at the end of 1999 that imposed fixed exchange rate and floating interest rate in an attempt to reduce inflationary pressures through expectation instead ended up increasing the domestic demand and causing a high level of current account deficit. A political uncertainty that emerged in February 2001 put the already fragile economy into a crisis, the payments

system was locked and the exchange rate was left to fluctuate. As of 2001, Türkiye has become a country with the highest dollarization level among developing countries.

Foreign currency denominated deposit ratio tended to decrease after the financial crisis in 2001 until 2012, but started to increase again from that point on. The reasons to be counted for the most recent increase in dollarization such as decreased confidence in monetary policy in Türkiye, accelerating inflation with external and geopolitical factors chronologically specified as the USA – China trade war, COVID pandemic and Russia – Ukraine war in addition to authorities in developed countries rising interest rates. Sudden increase in the dollarization trend by the end of 2021 is observed to be mitigated as the Turkish authorities have taken extensive yet complicated measures to protect Turkish Lira, the most effective and costly being the introduction of the foreign exchange protected deposit accounts (KKH).

The KKH scheme consists of two legs; TL accounts to be opened under the support of the Ministry of Treasury and Finance (MoTF) and conversions from foreign currency (FX) deposits to TL accounts to be supported by the CBRT. The system is based on the encouragement of depositors to shift to TL-denominated assets with compensation by the public sector for any losses that may arise from exchange rate fluctuations while providing a return in Turkish lira. Through these incentives, it was aimed to support financial stability by increasing the share of the Turkish lira in the total deposits in the banking system².

The stabilization of the Turkish lira by reducing the demand for foreign currency deposits is thought to limit the potential burden of the KKH scheme on the budget, in addition to the purchase of foreign currency during conversion to currency-protected TL deposits strengthening of Central Bank reserves. However, with these policies continuing for more than one year and KKH accounts reaching up to 24% of total deposits and 43% of TL denominated deposits³, are placing a growing burden on the

² Inflation Report 2022 – I, Box 2.1, CBRT

³ BRSA Weekly Banking Sector Statistics, 7 July 2023

public budget including tax exemption provided on returns from KKH accounts and on corporation tax on the banks in order to support the scheme. As of June 2023, the compensation of the exchange rate difference in the MoTF's leg of the KKH scheme is transferred to the CBRT, lifting the burden off the public budget but at the same time bringing inflationary concerns.



III. LITERATURE REVIEW

Both historical evidence and existing studies suggest that economies become more fragile with high rates of currency substitution in the system and the authorities take costly measures inflating the public budget or slowing down the economic activity in order to reduce dollarization.

Although the literature on the topic of dollarization in Türkiye is vast, it leans heavily on the topic of determinants of dollarization rather than the effects of dollarization in Türkiye, studies with a throughout and quantitative analysis on the variables of the economy being even less. In addition, both debt dollarization of the corporate sector and deposit dollarization of the banking sector are investigated in studies. Since debt dollarization of corporate sector has decreased since 2019, attention of this literature review is diverted towards deposit/liability dollarization of the financial system. The literature on empirical modeling of deposit/liability dollarization is not very large in addition, there are a few study about effects of deposit dollarization on the vulnerability of the country to adverse external shocks. Existing literature mainly follows the relationship between dollarization and inflation or exchange rate volatility. Yılmaz (2022) determined with use of the time varying Granger causality results that dollarization causes exchange rate changes during eras of political tension and uncertainty whereas exchange rate changes are the cause of dollarization in eras of financial tensions and economic uncertainty. Similarly, Sever (2012) found a casualty relationship from dollarization to the exchange rate uncertainty both with Granger casualty test and exponential GARCH mean method whereas Sahbaz (2022) concluded on the same result with a VAR (Vector Autoregressive Model) model, a CCC-GARCH model with ARCH – LM test and Granger causality test. Konat et al (2022) found a feeding mechanism between deposit dollarization and foreign exchange market pressure index consisting of foreign exchange rate and CBRT foreign exchange reserves with a lag augmented VAR model. Özkul (2021) used Toda-Yamamoto

causality analysis and found causality relationships from deposit dollarization to inflation and to employment. A change of 1 point in deposit dollarization creates a positive change of nearly 0,5 points in inflation and 0,3 points in employment. Yılmaz and Uysal (2019) showed that dollarization rate is the cause of inflation at 10% significance level with Granger Causality test. Güney and Çakmak (2012) also tackle the relationship between inflation and dollarization, finding a two-way Granger causality between inflation and dollarization in Türkiye.

Some of the studies focus on the effects of the dollarization on the banking system. Isık and Yuncu (2022) studied the effects of deposit dollarization on banks' performance in Türkiye for the period of 2012-2017 with using panel data and Generalized Method of Moments (GMM), with results emphasizing a negative and significant effect on banks' return on equity and return on assets. Another study about the effect of dollarization on the profitability of the banking system of Tunay and Tunay (2023) made dynamic panel data estimations using the 2002-2020 period data. The study showed that dollarization positively effects bank performance when exchange rates are stable. In case exchange rate shock occurs, dollarization will increase the cost of resources and decrease capital profitability of banks. Sarıgül (2023) on the other hand studied the impact of dollarization on only state owned deposit banks with panel ARDL methods and found significant effect of dollarization on banks' profitability but with differing signs among the banks in the long term and short term.

There are also studies on the persistence of dollarization in Türkiye (Vatansever (2023), Baskurt (2005)) generally implying the existence of ratchet effect on dollarization behaviour of agents. Kaya and Kara (2022) analyzed the relationship between dollarization and economic growth in Türkiye with the Johansen cointegration method and find a positive relationship. Sadeghzadeh (2022) found that dollarization has positive effect on stock market both in the short and long run contrary to general expectations that instability causing dollarization would stock market to lose confidence. SVAR analysis is used in the study with foreign stock market index and money supply as control variables and results are assumed to reflect money base

expanding effect of holding foreign assets in the long run. Terzi and Kurt (2007) researched the effect of exchange rate on domestic inflation in presence of high and low levels of dollarization using VAR analysis. The results of the study showed that with high level of dollarization, exchange rate pass-through affect to domestic prices is higher.

As it is seen, almost all studies on the subject of dollarization in Türkiye work with historical data and econometric models, hence they are unable to capture the theoretic relations of macro variables with each other which DSGE models are capable of. There are numerous studies conducted on Turkish economy using DSGE models but none of the models used features dollarization so far as we are aware.

There are several ways of incorporating dollarization in an economic model that change according to the type of dollarization as shown by a number of examples in previous studies. Some studies include financial dollarization as a liability allocation problem on banks side. Yeyati and Broda (2006) investigated banks decision to attract liabilities denominated in foreign currency. The banks in the model hence have to choose the optimal currency composition of their liability portfolio in the face of lower dollar rates versus balance sheet imbalances caused by currency mismatch. The study results suggests differentiated guarantee schemes for deposits in different currencies in case of bankruptcy of a bank will reduce excess dollarization. Kitano and Takaku (2017)'s research examined the effect of capital controls on welfare of a country in presence of dollarization. The two country DSGE model contained banks that receive liabilities in foreign exchange only through foreign investors instead of domestic households. Loans to agents from banks are also only allocated in the domestic currency. Findings of the study showed that capital controls have more welfare enhancing effects in economies with liability dollarization.

Ize and Yeyati (2003) presented a Minimum Variance Portfolio model trying to assess the determinants of deposit and loan dollarization. Share of foreign currency both in depositors' and borrowers' portfolio is a function of inflation and real exchange

rate volatilities, with financial intermediaries establish the equilibrium in demand and supply of foreign exchange with foreign borrowing or lending. The results suggested that financial dollarization increases when volatility of inflation is higher than that of the exchange rate.

Others include it as households decision; Djukic et al (2017) incorporate financial euroization as a fixed ratio of deposits in foreign money of households' utility function whereas in some studies (Ohanyan (2016), Brzoza-Brzezina et al (2015)) dollarization ratios are considered as AR(1) processes. Brzoza-Brzezina et al (2015) constructed a small open economy model with housing loans denominated in domestic or foreign currency by defining a CES type function and considering dollarization ratios as AR(1) processes. The results of the study implied that foreign denominated loans are wealth reducing in the presence of both interest rate and exchange rate shocks. Also, foreign loans weaken the effect of monetary policy, and policies against the rise of foreign currency loans have short term contracting effect on the economy. Ohanyan (2016) studied an open economy DSGE model with dual-currency banking and endogenously determined dollarization. The DSGE model used deviated from the uncovered interest parity condition (the interest rate differentials determine the exchange rate) in order to achieve the endogeneous determination of dollarization via a CES type function. The study shows that even small amount of dollarization has significant effects on the dynamics of the economy. Urosevic and Grga (2014) applied a DSGE model for Serbian economy and modified the model to include specific features of the country such as dollarization. The modification included separating the yeoman⁴ farmers in the model as borrowers of foreign and domestic currency, also assumed households are only deposit holders in foreign currency. Their work showed that interest rate mechanism has weak effect on the economy because of the foreign currency indexed loans and deposits, opposite of exchange rate which has a strong effect. Vega (2004) assumed households as net savers in a small open economy and incorporated domestic and foreign currency denominated deposits of households in their budget restriction in order to add the role of exchange rates in a financially

⁴ A yeoman farmer consumes part of the goods he produces.

dollarized DSGE model and forecast especially the inflation more accurately for inflation targeting policies.

There are also studies that explore the price dollarization in economic models. Castillo (2006a) allowed producers to use domestic or foreign currency in setting their prices. In another work (Castillo, 2006b) households are given the option to buy in domestic and foreign currency and hence creating transaction dollarization, they divide their wealth between bonds, cash in domestic and foreign currencies before goods are purchased. The study showed that in an economy with transactions dollarization, foreign interest rate distorts consumption, saving and labor supply decisions, effecting inflation hence making impossible for central bank to stabilize the inflation and the output gap simultaneously.

Although many studies have been conducted, a more systematic and theoretical analysis that might give a better understanding on the effects of dollarization in the Turkish economy is insufficiently explored in the literature. This study aims to fill this gap by providing a DSGE model with financial sector and partial deposit dollarization for drawing a full and accurate picture of the dollarized Turkish economy during an increasing interest rate shock and to better understand the efforts to eliminate dollarization.

IV.A NEW KEYNESIAN DSGE MODEL FOR TURKIYE INCLUDING THE BANKING SECTOR

IV.A. The Setup

The model is a small open economy with a representative household, intermediate good producing firms, a final good and a capital good producer, a representative bank, the central bank as the regulator of monetary policy and the government included as economic actors. It is assumed that all actors make rational decisions and that households, banks, final goods and capital producers are uniform, that they engage exactly in the same behavior in a perfectly competitive market, hence all the supply and demand factor of these actors are homogeneous. These assumptions enable simplification of the model by providing a representative agent for each group of households, final good producers, capital producers and banks.

It is assumed that intermediate goods producer firms each produce a differentiated good with a production function that brings together labor and capital, price changes of the produced goods are costly and therefore these firms operate under monopolistic competition conditions. The final goods producer buys a bundle of the differentiated goods from the intermediate goods producer firms and a bundle of the imported intermediate goods from the rest of the world, transforming these two bundles together into a homogeneous product. Imported intermediate goods are incomplete substitutes for domestically produced intermediate goods and vice versa. The resulting final goods are either used domestically as consumer goods by the household, public goods by the government and investment goods by the capital producer or exported abroad. The assumption that only intermediate goods are

imported in this model is compatible with Türkiye as 81.6% of the imported goods in April 2022 were intermediate goods⁵.

The representative household provides labor supply and receives wage in return, chooses between consumption and wealth accumulation. Assets of the household consist of domestic and foreign deposits held by the household in banks, domestic and foreign securities, cash money and stock of housing. Household owns all firms and hence receives their profits. In addition, the household makes the housing stock it keeps available to the capital producers free of charge and the capital producer uses the housing stock as collateral in return for the loan it has obtained from the bank.

The capital producer adds the investment goods it purchases to their existing capital stock and provides them to intermediate goods producers as new capital in return for rent. The bank, on the other hand, lends the funds obtained through the domestic and foreign deposits of households to the capital producer and intermediate good producer firms. The bank also borrows from overseas and the Central Bank as lender of last resort to finance its lending activities. It is assumed that there is no maturity mismatch between bank loans and deposits for the sake of simplicity. In the model, the central bank creates the monetary policy by observing the Taylor rule and determines the ratio of required reserves that the bank has to keep at the Central Bank as well as the amount of foreign reserves kept against volatile capital flows in and out of the economy. The government is included in the model with expenditure on public goods funded by nominal riskless one-period bonds issued domestically and taxation of households.

⁵ TURKSTAT, Foreign Trade Statistics April 2022

IV.B. The Representative Household

The representative household maximize its lifetime expected utility function under budget constraint by choosing their consumption C_t , labor supply N_t , real monetary asset x_t , housing stock H_t .

$$U_t = E_t[\sum_{s=0}^{\infty} \beta^s \left\{ \frac{C_{t+s}^{1-\zeta^{-1}}}{1-\zeta^{-1}} + \eta_x \ln x_{t+s} + \eta_N \ln(1 - N_{t+s}) + \eta_H \ln H_{t+s} \right\}] \quad (1)$$

Budget constraint is given as follows:

$$D_t + (B_t^p + E_t B_t^{F,p}) + P_t^H \Delta H_t + \Delta M_t^p = P_t^s (w_t N_t - T_t) - P_t^s C_t + (1 + i_{t-1}^D) D_{t-1} + (1 + i_{t-1}^B) B_{t-1}^p + (1 + i_{t-1}^{F,p}) E_t B_{t-1}^{F,p} + J_t^I \quad (2)$$

Household benefits from consumption, the time spared for leisure $(1 - N_t)$, monetary assets and housing. β is the discount factor, $E_t[\cdot]$ is the expected value operator and η_x , η_N , η_H are the parameters of monetary asset, labor and housing preference. ζ shows the intertemporal elasticity of substitution, that is, the sensitivity of the consumption of the household to the real interest rate. The real monetary asset x_t is the geometric mean of real cash held by the household and bank deposits:

$$x_t = (m_t^p)^v d_t^{v-1}, \quad v \in (0,1).$$

In the budget constraint given by equation (2), $D_t = P_t^s d_t$ is nominal deposit kept by the bank, $M_t^p = P_t^s m_t^p$ is nominal cash holdings, P_t^H is housing price level, P_t^s is price of final product in domestic market, E_t is nominal exchange rate, B_t^p ($B_t^{F,p}$) is single-period (foreign) government bond held by households, i_t^D , i_t^B , $i_t^{F,p}$ denote nominal interest rates on deposits, domestic and foreign government bonds respectively. On the other hand, T_t shows the lump-sum tax collected from the households to meet the government's expenditures, w_t shows the wages of the

households for the labor they produce in one period. Households own all companies. J_t^l shows the profits of the household from intermediate goods producer companies at the end of the period. Since the final product, the capital producer and the bank operate in a perfectly competitive market, the net profit of these firms is zero and therefore is not included in the budget constraint.

The foreign government bond interest rate $i_t^{F,p}$ is defined by the following equation:

$$1 + i_t^{F,p} = (1 + i_t^w) (1 - \theta_t^{F,p})$$

In this definition, interest rate of the bonds issued by the rest of the world differs from the risk-free interest rate i_t^w determined in international markets by the ratio $1 - \theta_t^{F,p}$, which is endogeneously set by the equation $\theta_t^{F,p} = (\theta_0^{F,p}/2) (B_t^{F,p})$. Households can lend to or borrow from overseas with foreign government bonds and this equation demonstrates that households lend (borrow) more with lower (higher) interest rate. Considering the especially low levels of Türkiye's household holdings of foreign assets and liabilities, the $\theta_0^{F,p}$ value is assumed to be so high that $B_t^{F,p}$ is close to zero, thus not included in this study. Hence The international risk-free interest rate is determined by the first-order autoregressive equation AR(1):

$$\ln i_t^w = \rho_w \ln i_t^w + \xi_t^w, \quad \rho_w \in (0,1), \xi_t^w \sim N(0, \sigma)$$

In order to obtain maximum benefit, households decide on $C_t, N_t, d_t, H_t, m_t^p, B_t^{F,p}, B_t^p$ values in each period by taking as given the values of variables determined by other economic actors and their choices in the previous period. When the utility function given in (1) together with the budget constraint in (2) is maximized with respect to the variables, the following first-order conditions are generated :

$$N_t = 1 - \frac{c_t^{\zeta^{-1}} \eta_N}{w_t} \quad (3)$$

$$m_t^p = \frac{c_t^{\zeta^{-1}} \eta_x v (1+i_t^B)}{i_t^B} \quad (4)$$

$$d_t = \frac{c_t^{\zeta^{-1}} \eta_x (1-v) (1+i_t^B)}{i_t^B - i_t^D} \quad (5)$$

$$\frac{P_t^H H_t}{P_t^S} = \left\{ 1 - E_t \left[\left(\frac{1+\pi_{t+1}^H}{1+i_t^B} \right) \right] \right\}^{-1} \frac{\eta_H}{c_t^{\zeta^{-1}}} \quad (6)$$

$$C_{t+1}^{-\zeta^{-1}} = \frac{c_t^{-\zeta^{-1}}}{\beta} \left\{ E_t \left[\left(\frac{1+\pi_{t+1}^S}{1+i_t^B} \right) \right] \right\}^{-1} \quad (7)$$

π_{t+1}^H represents the inflation in housing prices and π_{t+1}^S represents the inflation in the price of final product sold in domestic market.

The equation (3) determines the trade-off between work and leisure. It shows that while other variables are constant, the time allocated to work increases with increase in wage. Equations (4) and (5) show the households demand for cash holdings and real deposit supply. According to (4), the desire to hold real cash is inversely related to the domestic bond interest rate; as the bond interest rate rises, households will tend to allocate their funds as government bonds rather than holding them as cash. (5) shows that real deposit supply of household depends negatively on the domestic bond interest rate and positively on the deposit interest rate. Equation (6) shows that household demand for housing depends positively on consumption, domestic market price of goods sold for consumption and negatively on housing price and interest rate on bonds. (7) is the Euler equation for consumption; it shows that the change in the consumption habit of household depends on interest rate on bonds, expected inflation in future domestic market price of final goods and also on the inter-period discount factor. Equality also implies that consumption is smoothed out in time; households

should be indifferent between consuming one unit today or saving today and consuming one unit in the future (Junior, 2015).

After deciding on the amount to keep as deposit $D_t = d_t P_t$, the household faces the problem of allocating deposit between domestic and foreign currency. Following Ohanyan (2006), the households deposit allocation problem can be described by maximizing the discounted sum of expected revenue obtained from deposits:

$$E_t[\sum_{s=0}^{\infty} \beta^s \{ (1 + i_{t+s}^{d,h}) D_{t+s}^h + (1 + i_{t+s}^{d,f}) D_{t+s}^f \frac{E_{t+1}}{E_t} - (1 + i_{t+s}^d) D_{t+s} \}] \quad (8)$$

$$\text{where } D_t = [(1 - \xi_t^d)^{1/\chi_d} (D_t^h)^{\chi_d - 1/\chi_d} + (\xi_t^d)^{1/\chi_d} (D_t^f)^{\chi_d - 1/\chi_d}]^{\frac{\chi_d}{\chi_d - 1}}$$

In equation (8), we assume that total deposit is a constant elasticity of substitution (CES) function of domestic and foreign currency deposits. ξ_t^d shows the percentage of foreign currency deposits in total deposits and χ_d is the constant elasticity of substitution between foreign and domestic currency deposits. Household's domestic and foreign currency deposit choice are derived as a result:

$$D_t^h = E_t \left\{ \frac{(1 + i_t^{d,h})}{1 + i_t^d} \right\}^{-\chi_d} (1 - \xi_t^d) D_t \quad (9)$$

$$D_t^f = E_t \left\{ \frac{(1 + i_t^{d,f}) \frac{E_{t+1}}{E_t}}{1 + i_t^d} \right\}^{-\chi_d} \xi_t^d D_t \quad (10)$$

Total return rate on deposit can be derived by replacing the domestic and foreign currency deposits in CES identity of total deposit with their solution in (9) and (10):

$$1 + i_t^d = [(1 - \xi_t^d)(1 + i_t^{d,h})^{(1-\chi_d)} + \xi_t^d E_t \left[(1 + i_t^{d,f}) \frac{E_{t+1}}{E_t} \right]^{(1-\chi_d)}]^{-\frac{1}{\chi_d}} \quad (11)$$

IV.C. Final Good Producer

The final good producer carries out the production in a perfectly competitive market by using homogeneous domestically produced and imported intermediate goods. The firm produces by using the production function with constant elasticity of substitution below:

$$Y_t = \left[\Lambda_D (Y_t^D)^{\frac{\eta-1}{\eta}} + (1 - \Lambda_D) (Y_t^F)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \quad \Lambda_D \in (0,1) \quad (12)$$

In the production function, Y_t^D is the basket of domestic intermediate goods supplied by intermediate good producers and used in the final product, Y_t^F is the basket of intermediate goods imported to be used in the final product, Λ_D is the ratio of domestic intermediate goods used in the final product, η is the elasticity of substitution between baskets of domestically produced and imported goods in production. Intermediate goods producers are assumed to operate in an imperfect market and product differentiation exists between intermediate goods, hence the baskets formed by both domestic and imported intermediate goods are defined as follows:

$$Y_t^i = \left[\int_0^1 (Y_{jt}^i)^{\frac{\theta_i-1}{\theta_i}} dj \right]^{\frac{\theta_i}{\theta_i-1}}, \quad i = D, F \quad (13)$$

The definition given in (9) enables the price of domestic and foreign intermediate goods baskets to be determined as follows:

$$P_t^i = \left[\int_0^1 (P_{jt}^i)^{1-\theta_i} dj \right]^{\frac{1}{1-\theta_i}}, \quad i = D, F$$

θ_i represents the elasticity of substitution among domestic or foreign intermediate goods, while Y_{jt}^i for $j \in (0,1)$ denotes production of the j 'th intermediate

good producer. By substituting the definition of the product bundle given in (9) into the production function (8) and considering the price determined by the domestic producer of intermediate good j for the product (P_{jt}^D) and the import price of foreign intermediate good j (P_{jt}^F) is already known, final good producer finds the amount of demand for the intermediate good that will minimize its cost:

$$Y_{jt}^i = \left[\frac{P_{jt}^i}{P_t^i} \right]^{-\theta_i} Y_t^i, \quad i = D, F \quad (14)$$

The demand for intermediate goods directly increases with increase in the final product to be produced and in the price of the final product and inversely decreases as the price of the intermediate good demanded increases. The final product producer's total demand for intermediate goods basket is found by maximizing (8) under the budget constraint:

$$\max_{Y_t^D, Y_t^F} Y_t P_t - Y_t^D P_t^D - Y_t^F P_t^F;$$

$$Y_t^D = \Lambda_D^\eta \left[\frac{P_t^D}{P_t} \right]^{-\eta} Y_t; \quad Y_t^F = (1 - \Lambda_D)^\eta \left[\frac{P_t^F}{P_t} \right]^{-\eta} Y_t \quad (15)$$

The final product producer price level is also derived from equations (12) and (15) as follows:

$$P_t = [\Lambda_D^\eta (P_t^D)^{1-\eta} + (1 - \Lambda_D)^\eta (P_t^F)^{1-\eta}]^{\frac{1}{\eta-1}} \quad (16)$$

The worldwide prices of imported intermediate goods are exogeneous, determined independently of the model, and are denoted by WP_{jt}^F for all j . In addition, prices of imported goods in home country (in domestic currency) includes a partial adjustment component:

$$P_{jt}^F = (E_t W P_{jt}^F)^{\mu^F} P_{jt-1}^{F(1-\mu^F)} \quad (17)$$

$\mu^F \in (0,1)$ shows the rate at which prices are adjusted with prices abroad. When $\mu^F = 1$, the domestic price of imported intermediate goods is determined entirely by the exchange rate and the overseas price of the product, and the retroactive price of the product has no effect. On the other hand, the foreign price of the exported final product is shown with $W P_t^x$, and the domestic price of the product is determined over the foreign price:

$$P_t^x = E_t W P_t^x$$

The amount of the final product exported abroad is associated with the ratio of export price to price of final product in domestic market P_t^s :

$$Y_t^x = \left[\frac{P_t^x}{P_t^s} \right]^\chi Y_0^x, \quad \chi > 0. \quad (18)$$

After determining the amount of product to be exported, the rest of the final product is sold in the domestic goods market:

$$Y_t^s = Y_t - Y_t^x. \quad (19)$$

IV.D. Intermediate Good Producer

Each domestic intermediate good $j \in (0,1)$ is produced by domestic intermediate good producer $j \in (0,1)$ using labor force (N_{jt}) and capital (K_{jt}), as represented by the Cobb-Douglas production function and sold in a monopolistic competitive market:

$$Y_{jt}^D = N_{jt}^{1-\alpha} K_{jt}^\alpha, \quad \alpha \in (0,1) \quad (20)$$

At the beginning of each period, capital demand of the intermediate goods producer is met by the capital producer and a return rate of r_t^K is paid for capital renting at the end of the period. However, the payment for the labor is done at the beginning of the term. As a result, intermediate goods producer borrows from the bank the amount of payment $L_{jt}^w = P_t^s w_t N_{jt}$ at the beginning of each period. The loan taken from the bank to provide labor is assumed to be risk-free, therefore i_t^R which is the borrowing interest from the Central Bank, is the only cost reflected. The repayment to the bank takes place at the end of the period and the nominal total cost equation of firm j is as follows:

$$TC_{jt} = (1 + i_t^R) P_t^s w_t N_{jt} + P_t^s r_t^K K_{jt}. \quad (21)$$

It is assumed there is perfect competition in the market of factors of production. Hence, the ratio of capital demand to labor demand for the cost minimazing firm is derived by using the identity given in (20) in the total cost formula (21):

$$\frac{K_{jt}}{N_{jt}} = \frac{\alpha}{(1-\alpha)} \cdot \left(\frac{(1 + i_t^R) w_t}{r_t^K} \right) \quad (22)$$

Using the information provided by (22) and (20) in the total cost equation (21), the marginal cost is found:

$$MC_t = \frac{(r_t^K)^\alpha [(1 + i_t^R) w_t]^{1-\alpha}}{(1-\alpha)^\alpha \alpha^\alpha}. \quad (23)$$

Marginal cost is the same for all intermediate good producers since the markets for factors of production (capital and labor) are perfectly competitive. Marginal cost depends on the rental rate of capital, policy rate and real wages.

Intermediate good producers have only up to a certain degree of power over the price of the goods they produce, depending on their ability to operate in a monopolistic

competitive market. In order to reflect the price stickiness of the monopolistic competition in the intermediate goods market, a real cost of the price change is assumed to incur while determining the price in each period. The firm chooses the price that will maximize the discounted real value of its total profits in the present and the future periods:

$$\max_{P_{j(t+s)}^D} E_t \sum_{s=0}^{\infty} \beta^s \lambda_{t+s} \left(\frac{J_{jt+s}^D}{P_{t+s}^D} \right) \quad (24)$$

J_{jt+s}^D in the problem represents the profit of one period. Cost of the price adjustment is affected by the deviation in the price of intermediate good j (P_{jt}^D) at t from its expected value, which is the price at $t-1$ increased by the inflation in domestic goods price. The cost is additionally affected by the parameter ϕ_I that shows the degree of price stickiness, price of the domestic intermediate goods bundle and the production level. The profit for the period is obtained by subtracting the production costs and price adjustment cost from the return of the period:

$$J_{jt}^D = (P_{jt}^D - P_t^D MC_t) Y_{jt}^D - \frac{\phi_I}{2} \left(\frac{P_{jt}^D}{(1 + \pi^D) P_{jt-1}^D} - 1 \right)^2 P_t^D Y_t^D, \quad \phi_I \geq 0.$$

The first-order condition, which is the solution to the problem in (24) determines the adjustment process of nominal price P_{jt}^D of intermediate good j :

$$\begin{aligned} & (1 - \theta_D) \lambda_t \left(\frac{P_{jt}^D}{P_t^D} \right)^{-\theta_D} \frac{1}{P_t^D} + \theta_D \lambda_t \left(\frac{P_{jt}^D}{P_t^D} \right)^{-\theta_D} \frac{MC_t}{P_t^D} - \lambda_t \phi_I \left\{ \left(\frac{P_{jt}^D}{(1 + \pi^D) P_{jt-1}^D} - 1 \right) \frac{1}{(1 + \pi^D) P_{jt-1}^D} \right. \\ & \left. + \beta \phi_I E_t \left\{ \lambda_{t+1} \left(\frac{P_{jt+1}^D}{(1 + \pi^D) P_{jt}^D} - 1 \right) \frac{P_{jt+1}^D}{(1 + \pi^D) (P_{jt}^D)^2} \frac{Y_{t+1}^D}{Y_t^D} \right\} \right\} = 0. \end{aligned} \quad (25)$$

IV.E. Capital Producer

The capital producer firm operates in a perfectly competitive market. The firm purchases a portion of the final product (I_t) from the final producer as an investment good at the beginning of the period, combining it with the existing capital after the depreciation with δ as the depreciation rate, to form the next period's capital stock:

$$K_{t+1} = I_t + (1 - \delta)K_t \quad (26)$$

Payment for purchase of the investment good is made at the beginning of the period, so the capital producer borrows from the bank an amount of $L_t^I = P_t^S I_t$. The probability that the capital producer will repay the bank is $q_t \in (0,1)$ and the bank's interest rate for the loan to the capital producer is set at i_t^L . Capital producers total cost with repayment probability q_t is then $(1 + i_t^L)P_t^S I_t$. In case of failure in repayment and the loan defaults with the probability of $(1 - q_t)$, producer's cost is $\kappa P_t^H H$ which is the market value of the housing stock acquired from the household at no cost and used as collateral against bank debt. $\kappa \in (0,1)$ indicates a certain ratio of the market value of the house and H indicates the stock of housing. In this case, the nominal profit of the firm for one period is as follows:

$$J_{jt}^K = r_t^K K_t - [q_t(1 + i_t^L)P_t^S I_t + (1 - q_t)\kappa P_t^H H]$$

In this case, the capital producer chooses the capital production level that will maximize its real profitability:

$$\max_{\{K_{t+s+1}\}_{s=1}^{\infty}} E_t \sum_{s=0}^{\infty} \beta^s \lambda_{t+s} \left(\frac{J_{jt+s}^K}{P_{t+s}^S} \right) \quad (27)$$

Solution to the maximization problem in (27) gives the optimal capital loan rate r_t^K that the capital producer must decide to meet the capital demand of the intermediate goods producer:

$$E_t[r_{t+1}^K] = E_t \left[\frac{q_t(1+i_t^L)(1+i_t^B)}{(1+\pi_{t+1}^P)} - q_{t+1}(1+i_{t+1}^L)(1-\delta) \right] \quad (28)$$

IV.F. Bank

At the beginning of each period, the bank accepts deposits from households, borrows $L_t^{F,B}$ from abroad and $L_t^{C,B}$ from central bank; provides loans to producers of capital and intermediate goods with the funds obtained as well as keeping RR_t of the accepted deposits in the central bank as required reserves. At the end of the period, its debt to the central bank is repayed with an interest rate of i_t^R . The balance sheet of the bank is as follows:

$$L_t^W + L_t^I + RR_t = D_t^h + D_t^f + E_t L_t^{F,B} + L_t^{C,B} \quad (29)$$

Central bank makes no payment for required reserves it keeps. There are separate reserve requirement ratios for both reserves held in domestic currency and foreign currency, denoted by μ^d and μ^f respectively. A composite reserve requirement ratio is calculated as weighted average of μ^d and μ^f :

$$\mu^R = \frac{\mu^d D_t^d + \mu^f D_t^f}{D_t}.$$

Reserve requirement is thus calculated as $RR_t = \mu^R D_t$. The cost of borrowing abroad $i_t^{F,B}$ is defined as:

$$1 + i_t^{F,B} = (1 + i_t^W)(1 + \theta_t^{F,B})E_t \left[\frac{E_{t+1}}{E_t} \right] \quad (30)$$

The definition in (26) shows that the cost of foreign borrowing is more than the risk-free interest rate determined in international markets by the risk premium $\theta_t^{F,B}$. Risk premium is defined as $\theta_t^{F,B} = (\theta_0^{F,B}/2)(L_t^{F,B})$ and increases with the amount of

borrowing of the bank from abroad. On the other hand, the cost of foreign borrowing also varies depending on the expectations in the exchange rate movement.

The bank maximizes its profitability by determining deposit and loan interest rates and the amount to be borrowed from abroad. However, unlike other economic actors, it is assumed that the bank is liquidated at the end of each period and re-established in the next period. Therefore, the bank does not maximize its lifetime profit expectation, but only maximizes its expected profit over one period:

$$\max_{i_t^{d,f}, i_t^{d,h}, i_t^L, L_t^{F,B}} E_t \left[\frac{J_t^B}{P_t^S} \right]$$

The expected real profit is as follows:

$$E_t \left[\frac{J_t^B}{P_t^S} \right] = E_t \left[(1 + i_t^R) \frac{L_t^W}{P_t^S} + q_t (1 + i_t^L) \frac{L_t^I}{P_t^S} + (1 - q_t) \kappa P_t^H \frac{H}{P_t^S} + RR_t - (1 + i_t^{d,h}) \frac{D_t^h}{P_t^S} - (1 + i_t^{d,f}) \frac{E_{t+1} D_t^f}{E_t P_t^S} - (1 + i_t^{F,B}) \frac{E_t L_t^{F,B}}{P_t^S} - (1 + i_t^R) \frac{L_t^{C,B}}{P_t^S} \right] \quad (31)$$

The solution of the expected profit maximization problem gives the following first order equations:

$$i_t^{d,h} = \left(1 + \frac{1}{n_D^h} \right)^{-1} (1 - \mu^d) i_t^R \quad (32)$$

$$\left[\left(1 + \frac{1}{n_D^f} \right) i_t^{d,f} + 1 \right] E_t \left[\frac{E_{t+1}}{E_t} \right] = [(1 - \mu^f) i_t^R + 1] \quad (33)$$

$$1 + i_t^L = \left(1 + \frac{1}{\eta_F} \right)^{-1} \frac{(1 + i_t^R)}{q_t} \quad (34)$$

$$L_t^{F,B} = \max \left[\frac{(1+i_t^R) - (1+i_t^W)E_t \left[\frac{E_{t+1}}{E_t} \right]}{\theta_0^{F,B} (1+i_t^W)E_t \left[\frac{E_{t+1}}{E_t} \right]}, 0 \right] \quad (35)$$

In first order equations, n_D^h and n_D^f denote the deposit interest rate elasticity of household deposits; in other words, it shows the degree to which the deposit supply is affected by the change in the deposit interest rate. η_F shows flexibility of the Bank's foreign borrowing to the foreign borrowing rate. In other words, it shows the degree to which foreign borrowing demand is affected by foreign borrowing interest rate changes. In equations (32) - (34), it is seen that deposit and foreign borrowing costs are less than the cost of borrowing from the central bank in proportion to their flexibility. In addition, the implicit cost of setting reserve requirements is added to the deposit cost in the equation (32) – (33). In equation (34), the cost of foreign borrowing is inversely proportional to the probability of repayment of the debt; decrease in the probability of default indicates the state of the economic environment and reduces the risk of borrowing, which has a reducing effect on the cost. Equation (35) indicates borrowing from abroad as long as the risk-free foreign borrowing cost including the exchange rate effect is below the domestic (central bank) borrowing cost.

In the model, the probability of debt repayment, q_t , is assumed to depend on the effective collateral to loan ratio and cyclical state of the economy:

$$q_t = \left(\frac{\kappa P_t^H}{L_t^I} \right)^{\varphi_1} \left(\frac{Y_t}{\tilde{Y}} \right)^{\varphi_2}, \quad \varphi_1, \varphi_2 \in (0,1). \quad (36)$$

While the first part of the equation shows the moral risk on the borrower's side with the ratio of the collateral provided by the borrower to the borrowed amount, the second part shows the state of the economy as the ratio of total production to $\tilde{Y}$, the production in equilibrium.

After determining the amount of foreign borrowing, the Bank provides the rest of the demand from the Central Bank, As the lender of last resort, the financing provided by the Central Bank is indicated by the equation:

$$L_t^{C,B} = \max[L_t^w + L_t^l - RR_t - D_t - E_t L_t^{F,B}, 0] \quad (37)$$

IV.G. Central Bank

Central Bank's assets consists of international reserves $E_t R_t^F$, government bonds B_t^C and loans to the bank $L_t^{C,B}$; whereas liabilities consists of required reserves RR_t and cash M_t . It transfers the income obtained from international reserves and funds provided to banks to the government at the end of the period. Central Bank's balance sheet is shown with:

$$E_t R_t^F + B_t^C + L_t^{C,B} = RR_t + M_t^S \quad (38)$$

In the model, it is assumed that the central bank aims to protect the economy against volatile capital flows by setting an international reserve target $(R_t^{F,T})$, set by imports of intermediate goods and net foreign borrowing of the private sector:

$$R_t^{F,T} = (\phi_1^R W P_t^F Y_t^F)^{\varphi^F} \left(\phi_2^R (L_t^{F,B} - B_t^{F,P}) \right)^{1-\varphi^F}, \varphi^F \in (0,1), \phi_1^R, \phi_2^R > 0. \quad (39)$$

$\varphi^F, \phi_1^R, \phi_2^R$ in equation (39) are parameters specifying the purpose of the Central Bank; if the parameters are set such that $\varphi^F = 0, \phi_2^R = 1$, central bank's goal is to set the country's foreign net overall position $NFA_t = R_t^F + B_t^{F,B} - L_t^{F,B}$ to zero. In the case of $\varphi^F = 1, \phi_1^R = 1$ it can be said that the central bank aims to keep a reserve stock as much as the imports.

Central Bank's actual reserves are determined through target reserves, in addition to a partially backward looking component:

$$R_t^F = (R_t^{F,T})^{\varphi^R} (R_{t-1}^F)^{1-\varphi^R}, \quad (40)$$

$\mu^R \in (0,1)$ shows the rate at which the actual reserves reach the target reserve level. Money supply is derived from equation (38):

$$M_t^S = E_t R_t^F + B_t^C + L_t^{C,B} - RR_t \quad (41)$$

Central Bank determines its' policy rate in accordance with an extended Taylor Rule in the following equation:

$$i_t^R = \gamma i_{t-1}^R + (1 - \gamma) \left[\tilde{r} + \pi_t^S + \varepsilon_1 (\pi_t^S - \pi^{S,T}) + \varepsilon_2 \ln \frac{Y_t}{\bar{Y}} + \varepsilon_3 \Delta \ln E_t \right], \quad \gamma \in (0,1), \quad (42)$$

Here, $\pi^{S,T}$ is the inflation target of Central Bank and $\tilde{r}$ is bond interest rate at equilibrium. $\varepsilon_1, \varepsilon_2, \varepsilon_3 \geq 0$. In this context, Central Bank takes inflation, state of the economy in the cycle, market interest rate and changes in the exchange rate into account while determining the policy rate. The policy rate is also partially backwards looking with the parameter γ , which indicates the degree of interest rate smoothing.

IV.H. Government

The representative state buys a portion of the final product sold domestically ($G_t = \psi Y_t^S$), finances its budget by taxing households (T_t) and by issuing nominal single-term risk-free bonds B_t^C purchased by the Central Bank and B_t^P purchased by the household, but does not borrow from abroad. Government's budget is given by the following equation:

$$B_t^C + B_t^P + i_{t-1}^R L_{t-1}^{C,B} + i_{t-1}^W E_t R_{t-1}^F = P_t^S (G_t - T_t) + B_{t-1}^C + (1 + i_{t-1}^B) B_{t-1}^P \quad (43)$$

Both the government and the central bank is assumed to keep the stock of total bonds issued and held fixed in time, which means the amount of bond held by the household is also constant between periods: $B_t^C + B_t^P = \overline{B}^C + \overline{B}^P$.



V. GENERAL EQUILIBRIUM AND STEADY STATE

V.A. General Equilibrium

The intermediate goods produced by the firms are identical in symmetric equilibrium, resulting $Y_{jt}^D = Y_t^D, N_{jt} = N_t, K_{jt} = K_t$. For each intermediate good, supply equals demand, and the market clearing conditions can be written in aggregate terms:

$$Y_t^S = C_t + G_t + I_t + \frac{\phi_I}{2} \left(\frac{P_{jt}^D}{(1+\pi^D)P_{jt-1}^D} - 1 \right)^2 P_t^D Y_t^D. \quad (44)$$

The last term in the equation is the cost of change in intermediate good prices. Price of the final good sold in the domestic goods market is determined over the total value of production and sales of final good producer being equal in perfect competition ($P_t Y_t = P_t^S Y_t^S + P_t^X Y_t^X$):

$$P_t^S = \frac{P_t Y_t - P_t^X Y_t^X}{Y_t^S}. \quad (45)$$

Equilibrium in the money market is achieved by equating the cash demand of households and loan demand of firms with the central bank money supply, assuming that loan supplied to firms are in cash:

$$M_t^S = L_t^W + L_t^I + M_t^P. \quad (46)$$

By using the definitions given in (4), (37) and (5) for m_t^P , $L_t^{C,B}$ and RR_t as well as using equation (41) for M_t^S , the equilibrium bond interest rate i_t^B can be derived from the equation (46).

The balance of payments indirectly determines the exchange rate level and is given as follows in foreign currency:

$$WP_t^X Y_t^X - WP_t^F Y_t^F + i_{t-1}^W NFA_{t-1} - \theta_{t-1}^{F,P} B_{t-1}^{F,P} - \theta_{t-1}^{F,B} L_{t-1}^{F,B} - \Delta NFA_{t-1} = 0. \quad (47)$$

V.B. Steady State Equations

During the steady state of the economy in which variables become stagnant and do not change between periods, inflation variables (since no price change occurs between periods) are zero along with the inflation target:

$$\pi^{S,T} = 0, \pi^S = 0, \pi^D = 0.$$

The steady state values of all variables can be written in terms of parameters and other steady state values from the definitions and first-order equations given in the model. An example is the steady state value of the marginal cost derived from the equation (23)

$$MC = \frac{(\theta_D - 1)}{\theta_D},$$

with the knowledge that the prices and volumes of both intermediate and final goods produced by the firms are identical and constant over time at steady state. Steady state solutions of interest rates are derived from equations (7), (32), (33), (34) and (42):

$$i^B = i^R = \frac{1}{\beta} - 1 = \tilde{r},$$

$$i^{d,h} = \left(\frac{1 + n_D^h}{n_D^h} \right)^{-1} (1 - \mu^d) i^R,$$

$$i^{d,f} = \left(\frac{1 + n_D^f}{n_D^f} \right)^{-1} (1 - \mu^f) i^R,$$

$$i^L = \left(1 + \frac{1}{\eta_F} \right)^{-1} \frac{(1 + i^R)}{q} - 1.$$

The equality of i^B and i^R at steady state indicates that the bank will not need to borrow from central bank in order to purchase risk-free government bonds, since no profit can be gained. On the other hand, it is seen that $i^L > i^B$ due to lending to firms being more risky than purchasing government bonds, hence the bank prefers to give loans rather than buy bonds. Moreover, in case the price elasticities of deposits n_D^f and n_D^h are high enough and the central bank does not implement the reserve requirement, the cost of funding by holding deposits and by borrowing from the central bank are equal ($i^{d,h} = i^{d,f} = i^R$). However, normally both $\left(\frac{1+n_D^f}{n_D^f} \right)^{-1} (1 - \mu^f) < 1$ and $\left(\frac{1+n_D^h}{n_D^h} \right)^{-1} (1 - \mu^d) < 1$ therefore $i^D < i^R$; this follows from equation (11) and the fact that both domestic and foreign currency deposit interest rates are lower than the cost of borrowing from the central bank. Ultimately $i^L > i^B$, $i^B = i^R$ and $i^R > i^D$ shows that $i^L > i^D$, describing the main purpose of a bank, that is making profit from accepting deposits from fund owners and lending to those in need of funds. The steady state solutions of the first order equations are fully covered in Appendix A.

In order to analyze the nonlinear dynamic stochastic model and results of an exogenous shock to world risk-free interest rate, equations in the model are approximated to their log linearized versions around the steady state equilibrium. The log linearized equations are given in Appendix B.

VI.CALIBRATION

There are a total of 38 parameters used in the functions describing the model in the previous section; steady-state values of the observed macroeconomic variables, autoregressive coefficients, behavioral parameters. Determining values of the parameters is important in obtaining results that accurately demonstrate the behaviour of the economy modelled. There are two methods used in determining the value of the parameters; namely estimation and calibration (Kumar, 2023) which can also be used jointly. According to the first of these, the value of the parameters can be estimated statistically with GLS (generalized least squares), ML (maximum likelihood) or more recently preferred Bayesian method (Ünal, 2020) with micro or macro level data of the economies studied. In calibration method, values are determined based on observations from historical data as well as using established knowledge from previous literature in assigning values to parameters. Calibration should be designed to accommodate significant empirical attributions in the economy studied. The parameter values should be chosen to enable the relations obtained in the steady-state of the model to be realized.

Convenience of abundant information from previous studies regarding developing countries including Türkiye along with the help of historical macroeconomic data has led to using calibration for parametrizing the model in this study.

Discount factor β is set to 0,99 close to previous studies centered around Türkiye (Alp and Elekdağ (2011), Çebi (2012), Yüksel (2013)) and this ratio points to 4% real interest rate. Intertemporal elasticity of substitution ς is set to 0,5 following literature (Ortiz et al. (2009), Yagcibasi and Yildirim (2017), Can et al. (2021)), whereas preference parameter for housing η_H is determined as 0,02 as in Agenor et al. (2014). Following Agenor et al (2009), both preference parameter for monetary assets η_x and

weight of cash in the real monetary assets of the household v are based on M2/GDP (the monetization ratio) and M1/total deposit ratios for Türkiye. Hence, March 2023 estimates of these values are set for η_x and v respectively, which are 0,6 and 0,35.⁶ Since the steady-state labor value $\bar{N}$ is assumed to be 0,33, which corresponds to 8 working hours a day according to the standard set by ILO⁷, the η_N value is calibrated from the steady state of equation (3) as 3,19.

Share of fx deposits in Turkish Banking System between periods of 2003 – 2022 when Turkish economy was considerably more stable is 42,3% on average, it is seen that this ratio went as low as 29,5% in February 2011 and it has reached to 64,5% in December 2021 as a result of Central Bank reducing its policy rate from 19% to 14% in the aforementioned period. Accordingly, share of foreign currency deposits in total deposits ξ_t^d is set at 0,45 for the benchmark calibration. Alternative values of 0 and 0,8 for this ratio will also be considered in order to see the effect of dollarization on economy. Due to lack of information regarding the elasticity of substitution between home and foreign currency deposits for Türkiye, χ_d is set as 5,2 which is the elasticity calculated for another middle – income country, Armenia in Ohanian (2016). Study conducted in Baskurt (2005) also suggests that elasticity of currency substitution is high in Turkey.

The Λ_D parameter, which shows the rate of use of the intermediate product in the final product, was set to be 0,7 in Agenor et al. (2014). On the other hand, Central Bank's January 2022 Inflation Report states that share of imported material in exporters' production (in manufacturing industry) was 28,6% in 2020, close to its historical average. Furthermore, in another study conducted by Akgündüz and Fendoğlu (2019), the share of imported inputs reaches approximately to 45% in

⁶ M1, M2 values are taken from quarterly released Monetary Progress Report published by CBRT

⁷ The very first ILO Convention, adopted in 1919 (see below), limited hours of work and provided for adequate rest periods for workers as explained in: "Working time in the twenty-first century", Report for discussion at the Tripartite Meeting of Experts on Working-time Arrangements (17–21 October 2011), p.3

production when the suppliers which are not final product producers are also taken into account. In light of these information, Λ_D parameter is set to be 0,6.

Elasticity of substitution between domestic and foreign intermediate goods η is set to be 0,8, and the coefficients of θ_F and θ_D , which show the intermediate good bundles' elasticity of substitution among the goods produced by each intermediate good producer j , are set to be 7,6 for both, so that the steady-state intermediate goods markup rate corresponds to 15 % as in Sekmen and Siklar (2016), Yucel (2013) and Alp and Elekdag (2011) . The cost parameter ϕ_I that causes rigidity in the price of intermediate goods is calibrated to be 65 in Can et al (2021). The pass-through parameter μ^F , reflecting the effect of change in the exchange rate on import prices, was determined as 0,5, which was found to be the average value in the study carried out for 35 countries by Soto and Selaive (2003).

For the price elasticity of exports χ , the value of 0,7 is used from Agenor and Alper (2014). The value of α , which shows the share of capital input in intermediate goods production technology was set at 0,3 (Yağcıbaşı and Yıldırım, 2017) .

Depreciation rate of capital is calibrated as low as 0,035 (Alp and Elekdag (2011); Yuksel (2013)) for Turkiye in previous studies, therefore it is kept at 0,03 as in Agenor and al. (2014).

As in many developing countries, financial system in Turkiye also has the practice of requiring collateral with its market value exceeding the value of the loan itself. Hence the effective collateral – loan ratio κ , which shows the ratio of the collateral exceeding the loan is kept low at 0,1 as in the study conducted by Can et. al (2021). Again in accordance with Can et al. (2021), the collateral elasticity φ_1 of the repayment probability is 0,05, and the cyclical output elasticity of repayment probability φ_2 is 0,2. $\theta_0^{F,B}$ is calibrated at 1, indicating that foreign loans received by the banking system correspond to 80% of its total loans received at the steady state. Interest rate elasticity of domestic and foreign currency deposits $\eta_{d,h}$ and $\eta_{d,f}$ are set

at 0,4 and 0,2 whereas interest rate elasticity of capital producer's borrowing demand is set at 3,45 following results of the work of Akin et al. (2014). The study indicates 1,74 as price elasticity of demand in credit market and 0,3 as price elasticity of total deposits. Foreign currency deposits are assumed to have lower interest rate elasticity since exchange rate is seen to have more significance in allocating foreign currency deposits.

Ratio of public spending in GDP is 11,8% in 2021⁸. Taking only household consumption, gross fixed capital (investment) formation, government final consumption and change in stocks⁹ as final domestic consumption, this value falls down to 11,3%. Therefore government share in domestic consumption ψ is set at 0,11.

Table 1 Total List of Parameters

Parameter	Value	Definition
β	0,99	Discount factor
ζ	0,5	Intertemporal elasticity of substitution in consumption
η_N	3,19	Preference parameter for leisure
η_x	0,6	Preference parameter for monetary asset
η_H	0,02	Preference parameter for housing
v	0,35	Share parameter in the index of money holdings
$\theta_0^{F,p}$	∞	Household foreign borrowing response to change in cost of borrowing
ρ_w	0,7	Persistence of risk free rate
Λ_D	0,6	Distribution parameter for final good
η	0,8	Elasticity of substitution between domestic&imported intermediate goods
χ	0,7	Price elasticity of exports
$\theta_D, (\theta_F)$	7,6	Elasticity of substitution in intermediate domestic (foreign) goods
α	0,3	Share of capital in production
ϕ_I	65	Adjustment cost parameter for intermediate good prices
δ	0,03	Depreciation rate of capital
μ^F	0,5	Share parameter in the index of foreign good price
$\theta_0^{F,B}$	1	Foreign borrowing response to change in cost of borrowing
κ	0,1	Effective collateral – loan ratio
φ_1	0,05	Elasticity of repayment prob. to collateral
φ_2	0,2	elasticity of repayment prob. to cyclical output
$\eta_{d,h}$	0,4	Interest rate elasticity of domestic currency deposits
$\eta_{d,f}$	0,2	Interest rate elasticity of fx deposits
η_F	3,45	Elasticity of CG prod. demand of loan to interest rate
$\mu^{d,h}$	0,08	Required reserve rate for domestic currency deposits
$\mu^{d,f}$	0,25	Required reserve rate for foreign currency deposits
γ	0,7	Central bank policy insistence (interest rate smoothing)

⁸ Data from TURKSTAT: <https://data.tuik.gov.tr/Bulten/Index?p=Yillik-Gayrisafi-Yurt-Ici-Hasila-2021-45834>

⁹ Change in stocks is estimated as residual between production and expenditure accounts and also includes statistical discrepancy (TURKSTAT)

φ^R	0,2	Weight of t-1 period reserves in t period reserves
ε_1	1,5	Response of policy rate to inflation deviations
ε_2	0,25	Response of policy rate to cyclical output
ε_3	0	Response of policy rate to nominal depreciation
φ^F	1	Weight of imported goods & foreign liabilities in reserve target
ϕ_1^R	2	Coefficient for imported goods in reserve target
χ_d	5,2	Elasticity of substitution between home and foreign currency deposits
ξ_t^d	0,45	Share of foreign currency deposits in total deposits
ψ	0,11	Government share in total domestic sales

As in Agenor et al (2014), Central Bank is initially assumed to be only concerned about terms of trade in the economy. In this regard share of imports in the foreign reserve target φ^F is calibrated as 1, rendering the share of foreign liabilities of the private sector ineffective in setting target for foreign reserves, whereas the coefficient of imports in reserve target ϕ_1^R is set to 2. This means that Central Bank aims to mitigate effects of volatile capital flows by setting aside foreign reserves equal to the amount of six months of imports, with each period in the model assumed to correspond to one quarter a year. Adjustment speed of actual foreign reserves to the reserve target φ^R is set at 0,2 as in Agenor et al (2014).

The required reserve ratio is 0,25 for foreign currency deposits and 0,08 for domestic currency deposits in line with the CBRT's policy. Policy interest rate smoothing factor γ is set at 0,7 following Alp and Elekdag (2011), Yüksel (2013) and Bari and Siklar (2016), close in value to 0,8 set in the work of Vitek (2017) regarding 40 countries including Türkiye. On the other hand, by determining $\varepsilon_1 = 1,5$, $\varepsilon_2 = 0,25$ ve $\varepsilon_3 = 0$ in accordance with the literature (Agenor et al. (2009), Sekmen and Siklar (2016), Bari and Siklar (2016), Yagciyasi and Yildirim(2017), Can et al. (2021)), it is assumed that inflation and economic fluctuations are taken into account in determining the monetary policy, whereas exchange rate change is not by the policy makers. Chosen values also appear to be close to inflation and output gap coefficient values 1,77 and 0,20 found for Türkiye in Ortiz et al. (2009).

Persistence coefficient of risk free world interest rate (degree of smoothing) is usually set between 0,7 and 0,95 for Türkiye in literature, and set to 0,7 (Alp and

Elekdag (2011)) in this study accordingly. The full list of parameters is given in Table – 1.



VII.A POSITIVE SHOCK TO WORLD RISKLESS INTEREST RATE

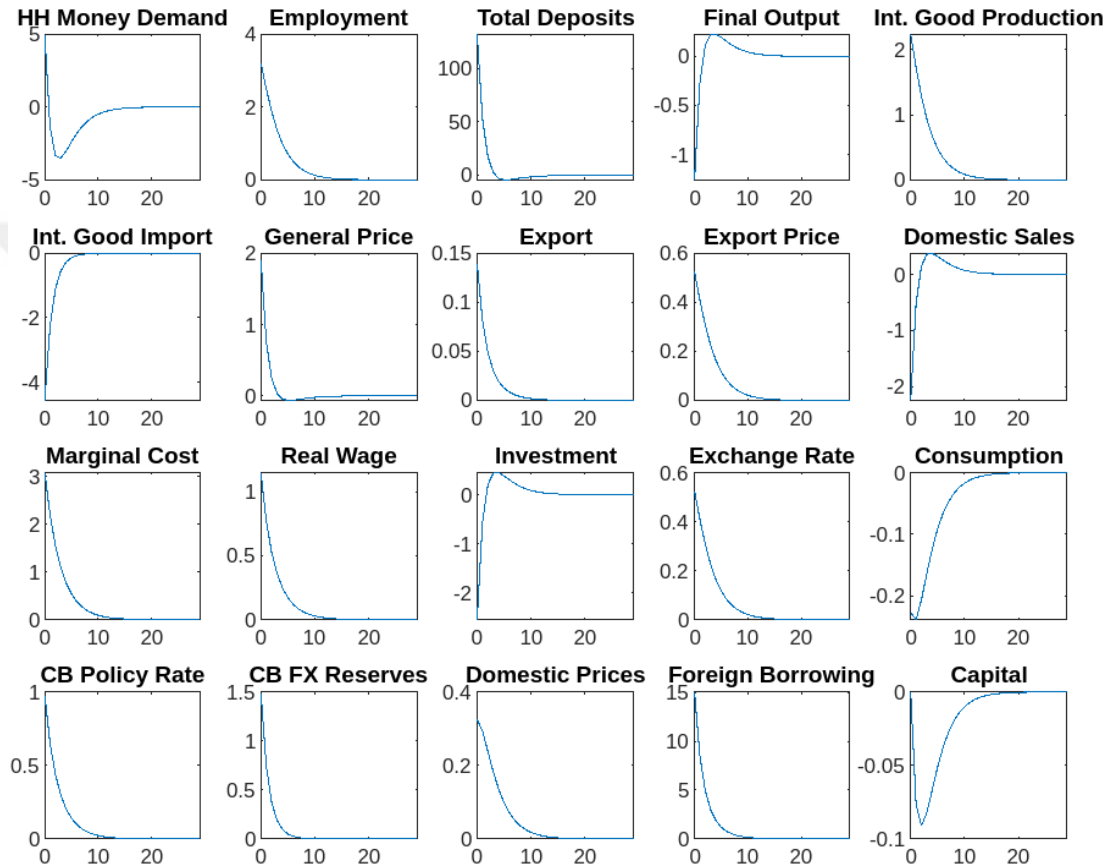
VII.A. Dynamics of a Sudden Increase in Worldwide Riskless Interest Rate– the Benchmark Case

In order to measure the response of the economy to external shocks, the foreign interest rate increases with a positive interest rate shock of 1 % quarterly is given to the worldwide risk free interest rate. The magnitude of the shock is sufficient to observe the effects of the shock. It is seen that there are differences between the effect of the shock in the first moment and the effect after a while. The expected reactions to the foreign interest rate shock in the most fundamental variables of the economy such as employment and production are shown in Figure 2 with impulse response functions created in the MATLAB. Impulse response functions of all variables are given in Appendix C.

Most direct effect of a positive shock to the riskless worldwide interest rate is on the cost and amount of borrowing from foreign institutions whereas exchange rate is determined implicitly in the model with respect to the external budget constraint of the country. As cost of borrowing from abroad increases, banks' borrowing from the abroad is expected to decrease initially. However, banks borrowing from abroad is also dependent on the loan demand of the private sector and the exchange rate. Even with increase in the cost of foreign borrowing, the initial level of exchange rate is high enough that cost of borrowing from abroad is still smaller than borrowing from the Central Bank. In the end, banks increase foreign borrowing in case of an increasing loan demand, which occurs at the same period $t = 0$. On the other hand, Central Bank increases its foreign reserves in order to maintain the external budget of the economy with increased level of foreign borrowing. Even though inflow of capital from foreign countries usually means appreciation of foreign exchange rate, this is not the case here as Central Bank's need for foreign reserves is much higher than foreign capital flowing

from foreign borrowing and net exports. Thus at the time of shock ($t = 0$), exchange rate increases. Effect of domestic currency depreciation is immediately seen on both export prices and import prices. Change in export prices increases supply of output to be exported. Increase in import price raises the producer price for final production which in turn raises price of final product sold in domestic market.

Figure 2 Benchmark Case: Impulse Response Functions - Temporary Increase in World Risk Free Interest Rate



Money supply of central bank is defined to depend positively on foreign reserves supply and negatively on foreign lending of banks and on deposits according to equation (41). Accumulation of foreign reserves is at a much higher rate than increase in the foreign lending of banks at the time of the shock. Additionally, the effect of change in foreign reserves on money supply is augmented more than the effect of change in deposits which is due to our calibration. Consequently, increase in foreign reserves dominates and monetary base expands. Bond rate decreases in order to clear the excess money supply in the money market. On the other hand, expected decrease in future inflation leads to increase in real bond rates, leads households to change their

consumption habits and consume less at present and more at future. Decreased nominal bond rates increase household demand for cash money. Diminishing nominal yields on holding government bonds along with decreasing consumption will induce households to direct their capital to alternative revenue sources such as households' cash holdings and deposits.

Central Bank adjusts its policy rate upwards with rising inflation in domestic market, as policy rate is designed to react more towards inflation than changes in output due to our calibration. Decreased consumption raises marginal utility of consumption, optimality requires that marginal utility of leisure lowers and causes households to increase their labor supply. Decrease in wages is expected with increase in labor supply; however, the upward movement in the policy rate (which is the rate of borrowing for intermediate goods producers to finance their working capital needs) ensures that the real wage rate increases. Increase in the policy rate also reflects into the cost of producing capital, increasing the lending rate at which the capital producer borrows from bank, resulting in a higher rental rate of capital. This in return increases labor demand of intermediate good producers in order to optimize their productivity. Increase in both labor supply and demand in labor creates employment and leads to increase in production of domestic intermediate goods.

Final good is a combination of domestically produced and imported intermediate goods. On the one hand, intermediate goods production increases with increased productivity. On the other hand foreign intermediate goods import decreases with increase in imported goods price. The effect of increase in domestic intermediate good is much less than the effect of decrease in imported intermediate goods, resulting in decrease in final output production.

Intermediate good production costs which are wages, rental rate of capital and policy interest rate that is also the cost of lending for wage payment at the beginning of the period increase the marginal cost of production. Increase in marginal cost

translates into inflation in price of goods produced domestically, also pushing the price of final goods exported and sold in the domestic market upwards.

Decrease in total output along with increase in exports brings about decrease in output allocated for domestic usage. Investments decline with decrease in output and capital production drops further pushing up rate of return to capital. Lending for capital production purposes decreases whereas inversely, lending for hiring labor increases and eventually the latter dominates and total lending increases. In order to meet the demand of more labor by intermediate good producers investment demand rises, magnifying further the already increasing investment lending rates originated from increased costs of financing from both abroad and Central Bank. Increasing demand for borrowing is financed by Bank through both increasing Central Bank and foreign lending.

Deferring current consumption increases marginal utility of consumption, decreasing the demand for housing and outweighs increasing effect of the fall in the real bond rate on the demand for housing. Downward direction of the demand for housing tends to decrease prices in real estate sector, the value of collateral that capital producing firms can use for borrowing drops.

Since fall in investment loans is much higher than fall in real estate prices, collateral – loan ratio rises with positive impact on repayment probability of intermediate good producers but this impact is suppressed by the decline in output given our calibration where elasticity of repayment probability is much higher on cyclical output than on collateral-loan ratio, causing repayment probability to decrease.

Both domestic and foreign currency deposits interest rate rise with increase in policy rate but in different amounts as foreign currency deposits interest rate adjusts to a lower rate taking exchange gains into consideration. Hence, weighted average deposit interest rate increases, further contributing to households demand for deposits. In this case, revenue of holding deposits in domestic currency (interest profit) and in

foreign currency (interest rate and foreign exchange profits) both change in similar amounts and therefore, deposit holdings in both domestic and foreign currency increase in similar ratio. Also change in total deposits is much larger than the difference between the interest rates of domestic and foreign currency deposits has negligible effect. In consequence, change in both domestic and foreign currency deposits is very similar to change in total deposits.

In the medium run, effect of exchange rate dampens both import and export prices and cost of production decreases with intermediate good import returning back to steady state level faster, while intermediate good production is still higher than steady state level after a while. Furthermore, domestic inflation on final goods sold domestically still persists. Also, households receiving additional income with increased employment help consumption escalate back and creates demand for production. Hence, a surge in production follows after the initial effect of the shock where final output production eventually ends up increasing above the steady state level before stabilizing.

Capital begins to diminish through decrease in investment one period after the shock is given yet after a while, allocation for investment increases with final production. Since investment demand exists with intermediate good production, capital level bounces back, further accelerating the production.

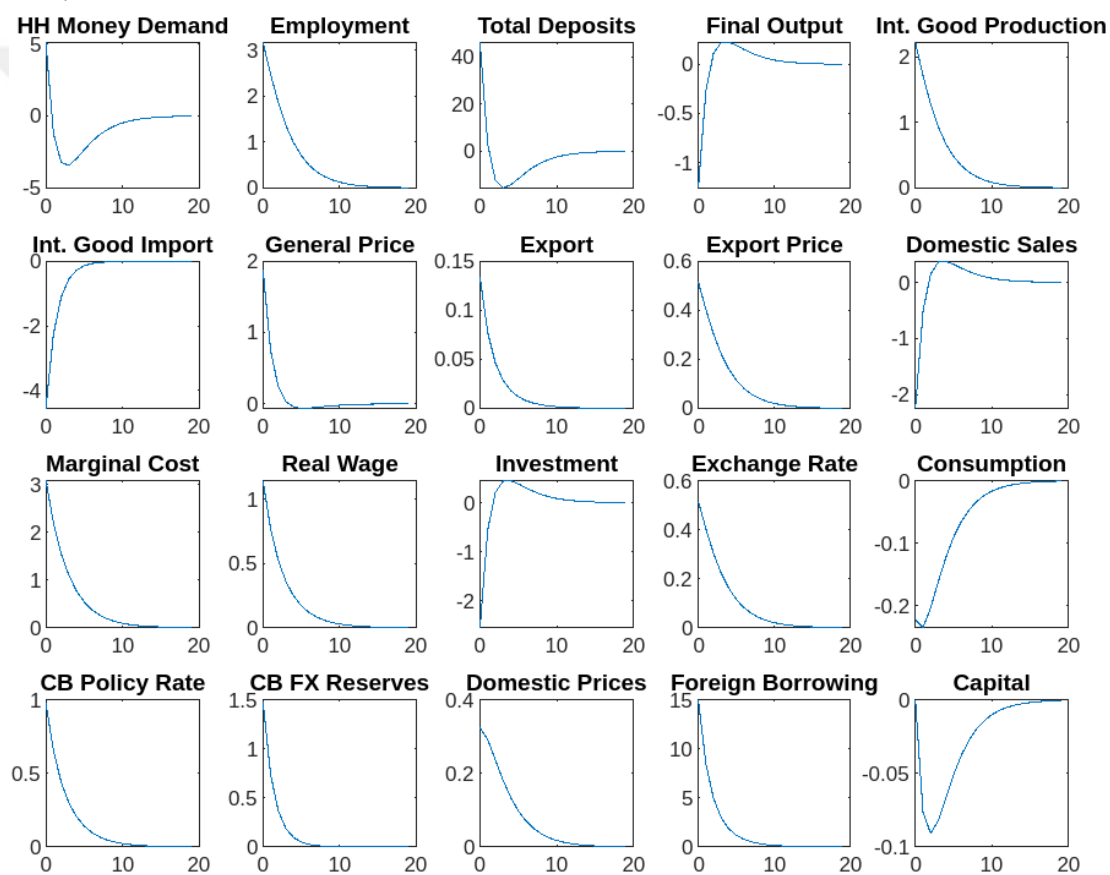
Lastly, elasticity of substitution between home and foreign currency deposit is taken to be a positive number in our calibration as it is also the case in Ohanian (2016). It was hence expected that holdings of foreign (domestic) currency deposits decrease when households expect an increase in the pay off of foreign (domestic) currency deposits which is actually not a rational choice for households and benefits banks instead. This could be explained with banks' financial understanding and prediction power over households or the expectations of households being backward looking instead of being rational and forward looking. However, this behaviour is not observed

in our model as the effect of elasticity of substitution is concealed with a very large increase in total deposits.

VII.B. Interest Rate Shock in an Economy with Deposit Dollarization

In order to assess the effect of deposit dollarization on the economy, we calibrate the share of foreign currency deposits in total deposits first as 0% i.e. no dollarization and later as 80%, and compare the results.

Figure 3 Impulse Response Functions - Temporary Increase in World Risk Free Interest Rate with 80% Deposit Dollarization Rate

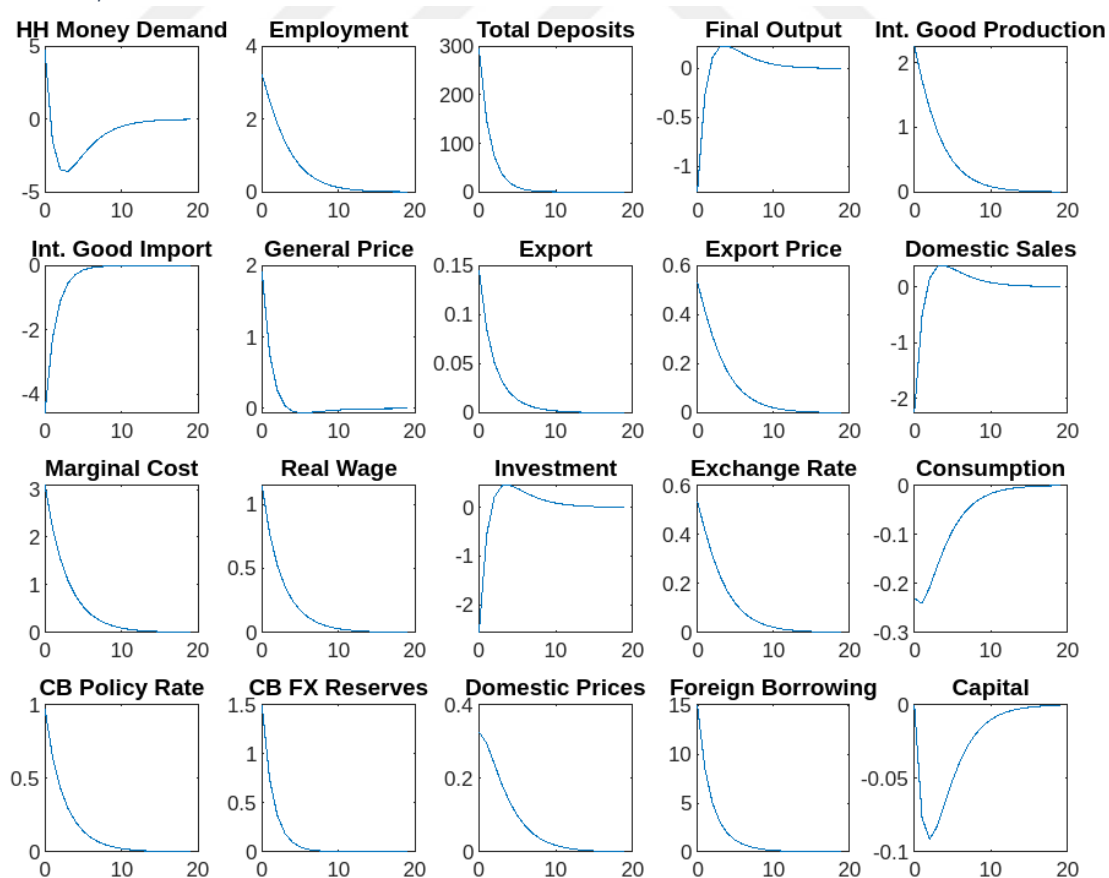


Behavior of the economy is generally similar in differing dollarization ratios with the base scenario; output, investment and consumption decrease, meanwhile exchange rate, exports, employment and real wages increase on impact. Nevertheless, degree of change is different for some of the key variables of the economy. Increase

in exchange rate in particular is suppressed as Central Bank's demand for foreign reserve is diminished.

While the deposit dollarization rate is higher, downward trend of consumption is mitigated with wealth effect stemming from the rise in exchange rate with high percentage of foreign deposits held by the households compared to when there is no deposit dollarization. Households are hence less inclined to increase their labor supply with their marginal utility of leisure rising more compared to households in a less dollarized economy due to their amplified consumption level. On the other hand, increase in labor demand of intermediate good producers in order to optimize their productivity is also mitigated since increase in exchange rate is also flattened, reflecting onto inflation in prices. Changes in both supply and demand sides of labor leads to increase in production of domestic intermediate goods and employment but to a lesser extent when deposit dollarization is higher.

Figure 4 Impulse Response Functions - Temporary Increase in World Risk Free Interest Rate with 0% Deposit Dollarization Rate



In the economy with high levels of deposit dollarization, mitigated increase in intermediate good production has downward effect on production. However, decrease in intermediate good import is also limited with lower price inflation, giving final producer access to imported goods more easily for production. The net effect is milder decrease in production of final good at the time of shock. Hence demand for total production increases along with production allocated for domestic use increase. Increase in production lessens the negative impact on investment, this also effects the drop in the level of capital positively. With deposit dollarization, total production level of the economy is effected less from the impact of rise in interest rates.

It is also worth noting that deposit interest rate increases by less compared to when deposit dollarization is lower at the steady state, exchange rate rising up lower with shock and decreasing the revenue from holding deposits. Households end up increasing their deposit holdings much less than in the case of lower deposit dollarization.

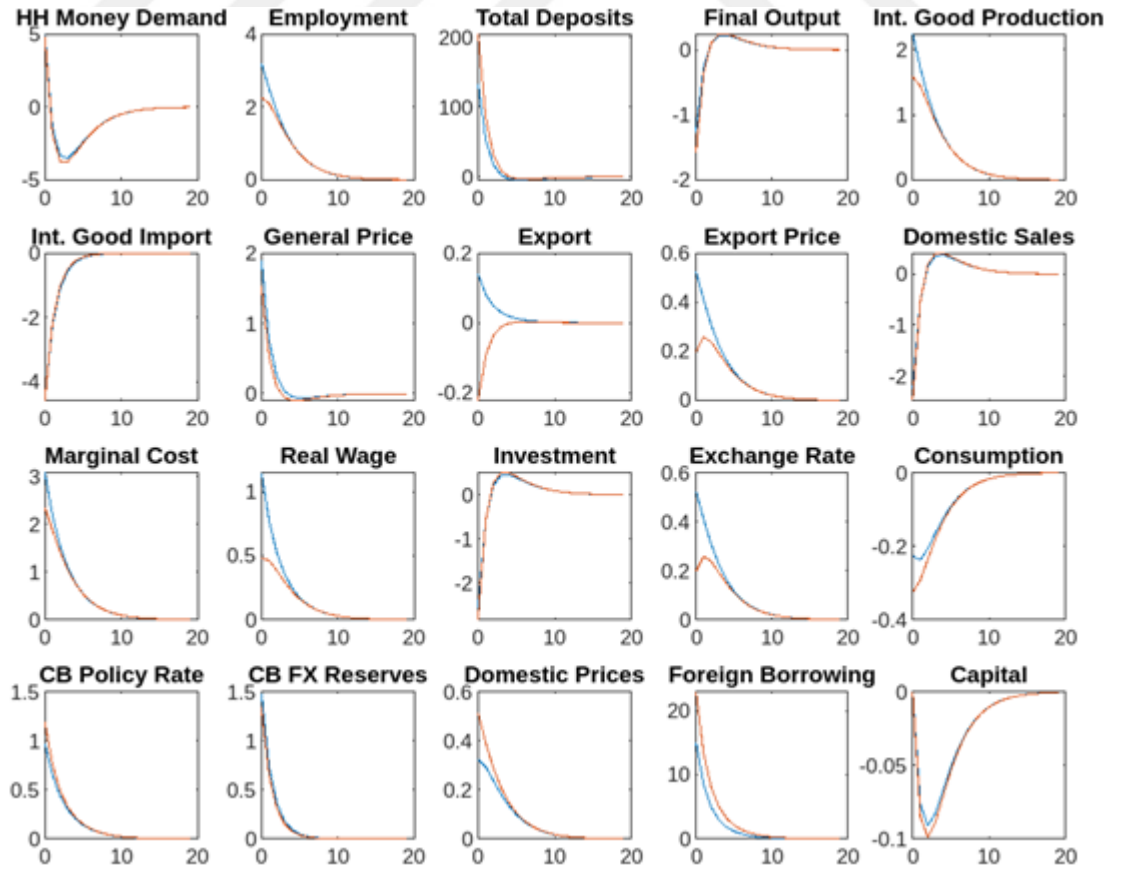
The results of the interest rate shock with existence of dollarization in the economy in this study has different results than the econometric studies conducted to tackle the relationship between dollarization and inflation or exchange rate volatility in Turkiye. Econometric studies generally found that dollarization caused inflation and exchange rate volatility while the results of our study showed that high dollarization rates mitigated the change in exchange rate and inflation. This could be due to the nature of our model, where dollarization rate is fixed and already high before the shock is given. Hence, the already high dollarization may be acting as protection against risk and also limiting the movement in the economy. Kaya and Kara (2022)'s econometric study that found a positive relationship between dollarization and economic growth in Turkiye on the other hand is in line with our results. Some of our results are more in line with Vega (2006) and Ohanian (2016) where an economic models is used instead of an econometric model. Vega (2006) found out that during strict inflation targeting regime, increase in dollar interest rate cause increase in dollarization but decrease in both real and nominal exchange rate. Ohanian (2016)'s study also suggests reduced contraction of the economy in case of high dollarization. Our study in addition provides

additional information on the state of the economy, such as the effect of dollarization on employment and wages.

VII.C. Sensitivity Analysis: Response to Change in Foreign Reserve Target to Imported Goods

Finally, to assess the sensitivity of the previous results, we consider an additional experiment where the parameter ϕ_1^R that captures the extent to which the Central Bank determines foreign reserve target in response to amount of imported goods is set to 4 from 2. This means that Central Bank aims to set aside foreign reserves equal to the amount of twelve months of imports. Results are shown in Figure – 5, where blue lines are the results of the benchmark experiment and orange lines are results with the new calibration of the parameter ϕ_1^R .

Figure 5 Impulse Response Functions - Temporary Increase in World Risk Free Interest Rate with Coefficient of Imports in Reserve Target Doubled



Increased target reserves means Central Bank has more reserves at steady state. Thus, increase in Central Bank's demand for reserves to maintain its external budget of the economy is less severe on impact which in turn softens the increase in exchange rate. Hence the initial drop in consumption is larger than in the benchmark experiment with the weakened wealth effect stemming from holding foreign currency deposits. Meanwhile, monetary base expands with increase in foreign reserves and bond rates drop more, dampening the rise in rental rate of capital and hence inversely mitigating the drop in marginal product of labor and in gross wages. Thus intermediate good producers' increase in labor demand is less than the benchmark case and the rise in the intermediate good production seen in the benchmark case is diminished as well, which in turn mitigates the production of final good compared to the benchmark experiment. This leads to shortage of supply induced inflation in domestically sold products by more than the benchmark experiment, which also amplifies the drop in consumption and investment, deepening the contraction in capital, magnifying the drop in intermediate good production, leading to a larger contraction in final output production. Additional factors such as domestic inflation and probability of repayment also effect the rental rate of capital more by dropping the cost of borrowing for capital producer and accordingly bolster the drop in production of intermediate good production. Magnified domestic inflation dampens the rise in rental rate of capital further by dropping the real value of collateral, while drop in total production reflects on probability of repayment, reducing it by more than the benchmark case; which means that capital producers lean more on the value of the collateral for the payment of loans which drops with inflation.

Moreover, Central Bank increases the policy rate more in order to confront the magnified domestic inflation. Cost of financing wages for intermediate good producer is the policy rate, hence increase in the policy rate increases costs for the intermediate good producers, further mitigating the increase in production of domestic intermediate good.

Amplified decrease in consumption magnifies the downward effect on marginal utility of leisure and causes households to increase their labor supply more while labor

demand is less, causing real wages to increase by less whereas employment also increase by less demand wise as explained above.



VIII.CONCLUSION

The aim of this study is to develop a dynamic stochastic model of a small open economy with banking intermediation structure, imperfect capital mobility and financial dollarization in order to see the impact of financial dollarization on the magnitude and scope of an interest rate shock on Turkish economy. The model features two levels of production with imperfect competition and nominal rigidity in intermediate good prices. In addition, the Central follows Taylor Rule in setting monetary policy against inflation and output gap. To calibrate the model, data on Turkish economy and calibration results of previous studies are used.

Our initial results show that a positive shock in worldwide interest rate results in a fall in household's consumption, with rising inflation triggered by a raise in exchange rate induced from excess demand of foreign reserves. Furthermore, a fall in intermediate good import also generated from the raise in exchange rate causes a reduction in the aggregate output and investment but a rise in real wages and labor occurs with increase in intermediate goods producers' productivity. Diminishing consumption enable agents to save more, whereas increase in both wages and employment increases demand for loans.

In order to catch the effect of deposit dollarization on economy, we compared the results of the same positive worldwide interest rate shock between a 0% and 80% deposit dollarization rate of the economy. We found out that the changes in the economy is mitigated as deposit dollarization of households increase. This means that fall in the aggregate output, consumption and investment along with the rise in the exchange rate is less when there is a higher rate of deposit dollarization. However, this cushioning effect is also seen in employment and real wages as increase in intermediate goods production is mitigated. When interpreting the results, it is important to account for the fact that dollarization itself largely arises as protection

against risk. Domestic lenders protect themselves by denominating contracts in a more stable, and thus less risky foreign currency and may decrease the vulnerability of the economy (Gulde et al (2004)).

Results of this study shows that deposit dollarization has positive effect on total production, a sign that could be interpreted as the economy doing well, but it also shows negative effect on employment and real wages. This means that even though the wealth effect of keeping deposit in foreign currency in case of an increase in exchange rate boosts the economic activity or mitigates the contraction of the economic activity as in our case, employment and real wages are negatively effected which may disturb social welfare.

Last but not least, we measured the sensitivity of the previous results by alternating the value of the coefficient of imported goods in Central Bank's target foreign reserve, as it is set to 4 from 2. The results imply that effects of worldwide interest rate shock do not change qualitatively when the calibrated value is changed. The difference in calibration have both mitigating and strengthening effect on variables but the directions of the variables do not change, demonstrating the robustness of the model.

New Keynesian DSGE models are advantageous with being independent of Lucas critique, having economic agents with rational expectations and being able to take disruptions in the market into account. In recent years, with the advances in the estimation techniques and programming languages of DSGE models, policy-making bodies have started to use these models extensively in their analysis. Even so, our model has weaknesses as well as strengths. Economic actors can be classified more specifically for reflecting behavior of actors into results more precisely; such as households that are differentiated as net borrowers and lenders, firms and banks differentiated by their activities. Also, economic and financial features specific to Turkiye such as addition of direct import of final goods from overseas can be included in the model in order to catch the effect of exchange rate change fully. In addition,

statistical tools can be explored in the calibration of the model with the most recent data for a better consistency of the model with the Turkish economy. Improvement in the model will enable a better understanding of the events and efficient usage of information in policy making.



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X.APPENDIX

Appendix A. List of Steady State Equations

1. $\tilde{r} = \frac{1}{\beta} - 1$
2. $\tilde{l}^B = \tilde{r}$
3. $\tilde{l}^R = \tilde{l}^B$
4. $\tilde{\pi}^S = \tilde{\pi}^{S,T} = \tilde{\pi}^H = 0$
5. $\tilde{r}^K = \left[\frac{(1+\tilde{l}^R)}{(1+\eta_F^{-1})} \right] \left(\frac{1}{\beta} - 1 + \delta \right)$
6. $\tilde{B}^{F,P} = 0$
7. $\tilde{H}^d = \bar{H}$
8. $\tilde{L}^{F,B} = \left[\frac{\tilde{r} - \tilde{l}^W}{\theta_0^{F,B} (1+\tilde{l}^W)} \right]$
9. $\tilde{R}^F = \tilde{L}^{F,B}$
10. $\tilde{Y}^F = \frac{(R^F)^{1/\varphi^F} (\phi_2^R (\tilde{L}^{F,B} - \tilde{B}^{F,P}))^{\varphi^F - 1}}{\phi_1^R \tilde{W}^F P^F}$
11. $\tilde{\theta}^{F,B} = \frac{\theta_0^{F,B} \tilde{L}^{F,B}}{2}$
12. $\tilde{Y}^x = \frac{\tilde{\theta}^{F,B} \tilde{L}^{F,B} + \tilde{W}^F P^F \tilde{Y}^F}{\tilde{W}^F P^x}$
13. $\tilde{M}C = \frac{\theta_D - 1}{\theta_D}$
14. $\tilde{P}^D = \frac{\theta_D}{\theta_D - 1} \tilde{M}C$
15. $\tilde{W} = \frac{\tilde{M}C (1-\alpha) \alpha^{\alpha/(1-\alpha)}}{(\tilde{r}^K)^{\alpha/(1-\alpha)} (1+\tilde{l}^R)}$
16. $\tilde{K} = \frac{\alpha \tilde{W} (1+\tilde{l}^R)}{(1-\alpha) \tilde{r}^K} \tilde{N}$

$$17. \tilde{Y}^D = \tilde{N}^{1-\alpha} \tilde{K}^\alpha$$

$$18. \tilde{I} = \delta \tilde{K}$$

$$19. \tilde{Y} = \left[\Lambda_D \tilde{Y}^D \frac{\eta-1}{\eta} + (1 - \Lambda_D) \tilde{Y}^F \frac{\eta-1}{\eta} \right]^{\frac{\eta}{\eta-1}}$$

$$20. \tilde{Y}^s = \tilde{Y} - \tilde{Y}^x$$

$$21. \tilde{C} = (1 - \psi) \tilde{Y}^s - \delta \tilde{K}$$

$$22. \eta_N = \frac{(1-\tilde{N})\tilde{w}}{\tilde{C}^{\frac{1}{\delta}}}$$

$$23. \tilde{m}^p = \frac{\eta_x v \tilde{C}^{\frac{1}{\delta}}}{(1-\beta)}$$

$$24. \tilde{d} = \frac{\eta_x (1-v) \tilde{C}^{\frac{1}{\delta}} (1+i^B)}{(i^B - i^D)}$$

$$25. \tilde{P}^F = \frac{1-\Lambda_D}{\Lambda_D} \tilde{P}^D \left(\frac{\tilde{Y}^F}{\tilde{Y}^D} \right)^{-1/\eta}$$

$$26. \tilde{E} = \frac{\tilde{P}^F}{W P^F}$$

$$27. \tilde{P}^x = \tilde{E} W P^x$$

$$28. \tilde{P} = \left[\Lambda_D^\eta \tilde{P}^{D^{1-\eta}} + (1 - \Lambda_D)^\eta \tilde{P}^{F^{1-\eta}} \right]^{\frac{1}{\eta}}$$

$$29. \tilde{P}^s = \frac{\tilde{P} \tilde{Y} - \tilde{P}^x \tilde{Y}^x}{\tilde{Y}^s}$$

$$30. \tilde{Y}^F = \tilde{Y}^x \left(\frac{\tilde{P}^x}{\tilde{P}^s} \right)^{-\chi}$$

$$31. \tilde{L}^w = \tilde{P}^s \tilde{w} \tilde{N}$$

$$32. \tilde{L}^I = \tilde{P}^s \tilde{I}$$

$$33. \tilde{P}^H = \eta_H \tilde{C}^{\frac{1}{\delta}} \frac{\tilde{P}^s}{\tilde{H}} \left[1 - \frac{1+\tilde{\pi}^H}{1+i^B} \right]^{-1}$$

$$34. \tilde{q} = \left[\frac{\kappa \tilde{P}^H \tilde{H}}{\tilde{L}^I} \right]^{\varphi_1}$$

$$35. \tilde{t}^L = \frac{1+\imath^B}{\tilde{q}(1+\eta_{\tilde{F}}^{-1})} - 1$$

$$36. \tilde{B}^C = (\tilde{m}^p + \tilde{d})\tilde{P}^s - \tilde{E}(\tilde{R}^F - \tilde{L}^{F,B})$$

$$37. \tilde{B}^p = \bar{B} - \tilde{B}^C$$

$$38. \tilde{t}^{d,h} = \left(1 + \frac{1}{\eta_D^h}\right)^{-1} (1 - \mu_h^R) \tilde{t}^R$$

$$39. \tilde{t}^{d,f} = \left(1 + \frac{1}{\eta_D^f}\right)^{-1} (1 - \mu_f^R) \tilde{t}^R$$

$$40. \tilde{t}^d = [\xi^d (1 + \tilde{t}^{d,f})^{1-\chi_d} + (1 - \xi^d) (1 + \tilde{t}^{d,h})^{1-\chi_d}]^{1/1-\chi_d} - 1$$

$$41. \tilde{d}^h = \left(\frac{1+\imath^{d,h}}{1+\imath^d}\right)^{-\chi_d} (1 - \xi^d) \tilde{d}$$

$$42. \tilde{d}^f = \left(\frac{1+\imath^{d,f}}{1+\imath^d}\right)^{-\chi_d} \xi^d \tilde{d}$$

$$43. \mu^R = \frac{\mu_h^R \tilde{d}^h + \mu_f^R \tilde{d}^f}{\tilde{d}}$$

$$44. \tilde{L}^{C,B} = \tilde{L}^w + \tilde{L}^I - \tilde{E} \tilde{L}^{F,B} - (1 - \mu^R) \tilde{P}^s \tilde{d}$$

$$45. \tilde{T} = \psi \tilde{Y}^s + \frac{\imath^B \tilde{B}^p}{\tilde{p}^s} - \frac{\imath^R \tilde{L}^{C,B}}{\tilde{p}^s} - \frac{\imath^w \tilde{E} \tilde{R}^F}{\tilde{p}^s}$$

Appendix B. List of Log – Linearized Equations

Static Equations

1. $\widehat{N}_t = \frac{\bar{c}^{\varsigma^{-1}} \eta_N}{\bar{w} - \bar{c}^{\varsigma^{-1}} \eta_N} \left[\widehat{W}_t - \frac{\bar{c}_t}{\varsigma} \right]$
2. $\widehat{m}_t^p = \frac{\bar{c}_t}{\varsigma} - \frac{\beta}{1-\beta} \hat{t}_t^B$
3. $\widehat{d}_t = \frac{\bar{c}_t}{\varsigma} + \left[\frac{1-\mu^R+\mu^R\beta}{\mu^R(1-\beta)} \right] (\hat{t}_t^D - \hat{t}_t^B)$
4. $\hat{Y}_t^D = \eta [\hat{P}_t - \hat{P}_t^D] + \hat{Y}_t$
5. $\hat{Y}_t^F = \eta [\hat{P}_t - \hat{P}_t^F] + \hat{Y}_t$
6. $\hat{P}_t = \Lambda_D \eta \left[\frac{\bar{P}^D}{\bar{P}} \right]^{(1-\eta)} \hat{P}_t^D + (1 - \Lambda_D) \eta \left[\frac{\bar{P}^D}{\bar{P}} \right]^{(1-\eta)} \hat{P}_t^F$
7. $\hat{Y}_t^x = \chi [\hat{P}_t^x - \hat{P}_t^s]$
8. $\hat{P}_t^x = \widehat{W} \hat{P}_t^x + \hat{E}_t$
9. $\tilde{Y} \hat{Y}_t = \tilde{Y}^x \hat{Y}_t^x + \tilde{Y}^s \hat{Y}_t^s$
10. $\alpha \hat{K}_t = \hat{Y}_t^D - (1 - \alpha) \tilde{Y}^s \hat{N}_t$
11. $(1 - \psi) \tilde{Y}^s \hat{Y}_t^s = \tilde{C} \hat{C}_t + \tilde{I} \hat{I}_t$
12. $\widehat{w}_t = \hat{K}_t - \hat{t}_t^R - \hat{N}_t + \left(\frac{1+\bar{r}^K}{\bar{r}^K} \right) \hat{r}_t^K$
13. $\widehat{M} \hat{C}_t = (1 - \alpha) [\hat{t}_t^R + \widehat{w}_t] + \alpha \left(\frac{1+\bar{r}^K}{\bar{r}^K} \right) \hat{r}_t^K$
14. $\hat{q}_t = \varphi_1 \hat{P}_t^H + \varphi_2 \hat{Y}_t - \varphi_1 \hat{L}_t^I$
15. $\hat{R}_t^{F,T} = \varphi^F [\widehat{W} \hat{P}_t^F + \hat{Y}_t^F] + \frac{(1-\varphi^F) \bar{L}^{F,B}}{(\bar{L}^{F,B} - \bar{B}^{F,P})} \hat{L}_t^{F,B} - \frac{(1-\varphi^F) \bar{B}^{F,B}}{(\bar{L}^{F,B} - \bar{B}^{F,P})} \hat{B}_t^{F,B}$
16. $\hat{L}_t^w = \widehat{w}_t + \hat{N}_t + \hat{P}_t^s$
17. $\hat{L}_t^I = \hat{I}_t + \hat{P}_t^s$
18. $\tilde{L} \hat{L}_t = \tilde{L}^w \hat{L}_t^w + \tilde{L}^I \hat{L}_t^I$
19. $\tilde{L}^{C,B} \hat{L}_t^{C,B} = \tilde{L} \hat{L}_t + \tilde{E} \tilde{L}^{F,B} \hat{L}_t^{F,B} - (1 - \mu^R) \tilde{P}^s \tilde{d} [\hat{d}_t + \hat{P}_t^s] - \tilde{E} \tilde{L}^{F,B} \hat{E}_t$

$$20. - \left[\eta_x v \tilde{C}^{\varsigma^{-1}} \frac{(1+\tilde{I}^B)}{(\tilde{I}^B)^2} + \eta_x (1-v) \tilde{C}^{\varsigma^{-1}} \frac{(1+\tilde{I}^B)(1+\tilde{I}^D)}{(\tilde{I}^B - \tilde{I}^D)^2} \right] \hat{I}_t^B = (\tilde{R}^F - \tilde{L}^{F,B}) \frac{\tilde{E}}{\tilde{P}^S} \hat{E}_t +$$

$$\frac{\tilde{E} \tilde{L}^{F,B}}{\tilde{P}^S} \hat{L}_t^{F,B} - \left[\frac{\tilde{B}^C}{\tilde{P}^S} + \frac{\tilde{E} \tilde{R}}{\tilde{P}^S} - \frac{\tilde{E} \tilde{L}^{F,B}}{\tilde{P}^S} \right] \hat{P}_t^S - \left[\eta_x v \tilde{C}^{\varsigma^{-1}} \frac{(1+\tilde{I}^B)}{\tilde{I}^B} + \eta_x (1 -$$

$$v) \tilde{C}^{\varsigma^{-1}} \frac{(1+\tilde{I}^B)(1+\tilde{I}^D)}{(\tilde{I}^B - \tilde{I}^D)^2} \right] \frac{\hat{C}_t}{\varsigma} - \eta_x (1-v) \tilde{C}^{\varsigma^{-1}} \frac{(1+\tilde{I}^B)(1+\tilde{I}^D)}{(\tilde{I}^B - \tilde{I}^D)^2} \hat{I}_t^D$$

$$21. \tilde{Y}^S \tilde{P}^S \hat{P}_t^S = \tilde{Y} \tilde{P} [\hat{Y}_t + \hat{P}_t] - \tilde{Y}^X \tilde{P}^X [\hat{P}_t^X + \hat{Y}_t^X] - \tilde{Y}^S \tilde{P}^S \hat{Y}_t^S$$

$$22. \left[\frac{\tilde{I}^{d,h}}{(1+\tilde{I}^{d,h})} \frac{(1+\tilde{I}^R)}{\tilde{I}^R} \right] \hat{I}_t^R = \hat{I}_t^{d,h}$$

$$23. \left[\frac{(1+\tilde{I}^R)}{\left(\frac{1}{(1-\mu_f^R)} + \tilde{I}^R \right)} \right] \hat{I}_t^R = \hat{I}_t^{d,f} \frac{(1+\tilde{I}^{d,f})}{\left(\tilde{I}^{d,f} + \frac{\eta_d^f}{1+\eta_d^f} \right)} - \hat{I}_t^W + \hat{I}_t^R - \left[\frac{\tilde{I}^R - \tilde{I}^W}{1+\tilde{I}^R} \right] \hat{L}_t^{F,B}$$

$$24. \hat{D}_t^h = \chi_d [\hat{I}_t^D - \hat{I}_t^{d,h}] + \hat{D}_t$$

$$25. \hat{D}_t^f = \chi_d [\hat{I}_t^D - \hat{I}_t^{d,f}] + \hat{D}_t + \chi_d \left[\hat{I}_t^W - \hat{I}_t^R + \frac{\tilde{I}^R - \tilde{I}^W}{1+\tilde{I}^R} \hat{L}_t^{F,B} \right]$$

$$26. \hat{I}_t^{F,B} = \hat{I}_t^R + \left[\frac{\frac{\theta_o^{F,B}}{2} \tilde{L}^{F,B}}{1 + \frac{\theta_o^{F,B}}{2} \tilde{L}^{F,B}} - \frac{\tilde{I}^R - \tilde{I}^W}{1+\tilde{I}^R} \right] \hat{L}_t^{F,B}$$

$$27. (1 + \tilde{I}^d)^{1-\chi_d} \hat{I}_t^d = \zeta^d (1 + \tilde{I}^{d,f})^{1-\chi_d} \hat{I}_t^{d,f} + (1 - \zeta^d) (1 + \tilde{I}^{d,h})^{1-\chi_d} \hat{I}_t^{d,h} +$$

$$\zeta^d \frac{[(1+\tilde{I}^{d,f})^{1-\chi_d} - (1+\tilde{I}^{d,h})^{1-\chi_d}]}{(1-\chi_d)} \hat{\zeta}_t^d + \zeta^d (1 + \tilde{I}^{d,f})^{1-\chi_d} (\hat{I}_t^R - \hat{I}_t^W - \left(\frac{\tilde{I}^R - \tilde{I}^W}{1+\tilde{I}^R} \right) \hat{L}_t^{F,B})$$

Dynamic Equations

$$1. \hat{C}_{t+1} = \hat{C}_t + \delta \hat{P}_t^S - \delta \hat{P}_{t+1}^S + \delta [\hat{P}_{t+1}^S - E_t(\hat{P}_{t+1}^S)] + [\hat{C}_{t+1} - E_t(\hat{C}_{t+1})] + \delta \hat{I}_t^B.$$

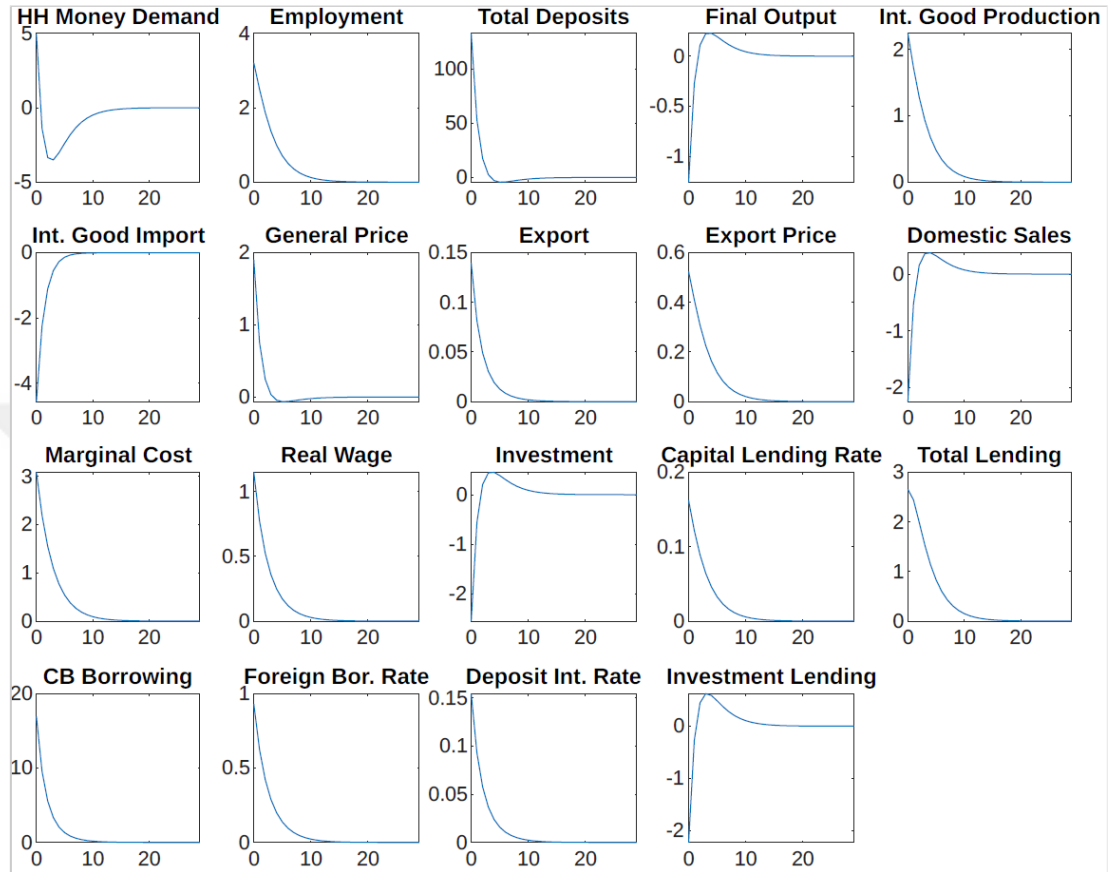
$$2. \frac{(1+\pi^H)}{(\tilde{I}^B - \tilde{\pi}^H)} \hat{P}_{t+1}^H = \hat{H}_t^d + \frac{(1+\tilde{I}^B)}{(\tilde{I}^B - \tilde{\pi}^H)} \hat{P}_t^H - \hat{P}_t^S + \frac{(1+\pi^H)}{(\tilde{I}^B - \tilde{\pi}^H)} \hat{I}_t^B + \frac{\hat{C}_t}{\delta} + \frac{(1+\pi^H)}{(\tilde{I}^B - \tilde{\pi}^H)} [\hat{P}_{t+1}^H - E_t(\hat{P}_{t+1}^H)]$$

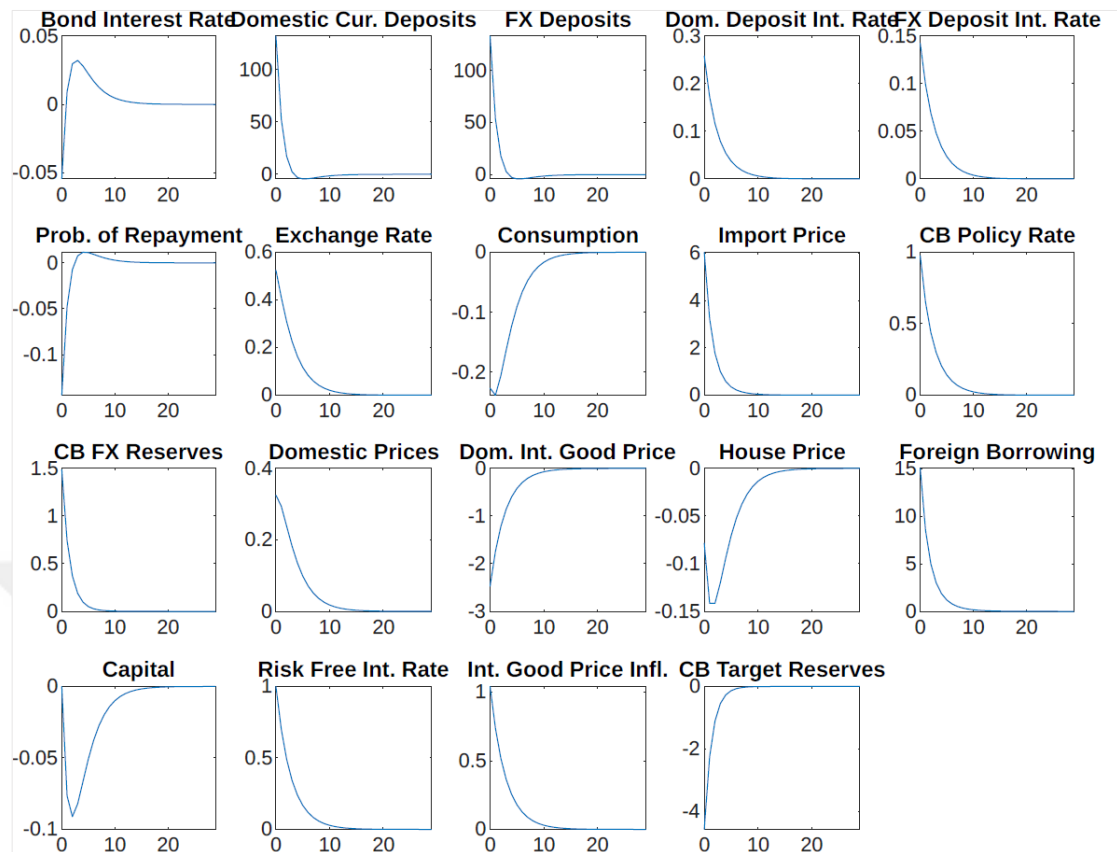
$$3. \hat{P}_{t+1}^F = (1 - \mu^F) \hat{P}_t^F + \mu^F [\hat{E}_{t+1} + \widehat{WP}_{t+1}^F]$$

4. $\frac{\hat{K}_{t+1}}{\delta_k} = \hat{I}_t + \frac{(1-\delta_k)}{\delta_k} \hat{K}_t$
5. $\hat{I}_{t+1}^R = X\hat{I}_t^R + \frac{(1-X)}{1+\bar{I}^R} [\varepsilon_1(\hat{P}_{t+1}^S - \hat{P}_t^S) + \varepsilon_2\hat{Y}_{t+1} + \varepsilon_3(\hat{E}_{t+1} - \hat{E}_t)]$
6. $\tilde{L}^{F,B}\hat{L}_{t+1}^{F,B} = \tilde{R}^F\hat{R}_{t+1}^F + \widetilde{WP}^F\tilde{Y}^F\hat{Y}_{t+1}^F - \widetilde{WP}^x\tilde{Y}^x\hat{Y}_{t+1}^x + [(1 + \theta^{F,B})\tilde{L}^{F,B} + \theta^{F,B}\tilde{L}^{F,B} + (1 + \bar{I}^w)\tilde{L}^{F,B}]\hat{L}_t^{F,B} - (1 + \bar{I}^w)\widetilde{NFA}\hat{I}_t^w - (1 + \bar{I}^w)\tilde{R}^F\hat{R}_t^F$
7. $\hat{R}_{t+1}^F = (1 - \varphi^R)\hat{R}_t^F + \varphi^R\hat{R}_{t+1}^{F,T}$
8. $\hat{P}_{t+1}^D = \hat{P}_t^D + \hat{\pi}_{t+1}^D$
9. $\hat{r}_{t+1}^K = \frac{q(1+\bar{I}^L)}{(1+\bar{r}^K)(1+\pi^S)} (\hat{P}_t^S + \hat{I}_t^B + \hat{I}_t^R) - \frac{q(1-\delta_K)(1+\bar{I}^L)}{(1+\bar{r}^K)} \hat{I}_{t+1}^R - \frac{q(1+\bar{I}^L)}{(1+\bar{r}^K)(1+\pi^S)} \hat{P}_{t+1}^S +$
 $[\hat{r}_{t+1}^K - E_t(\hat{r}_{t+1}^K)] + \frac{q(1-\delta_K)}{(1+\bar{r}^K)(1+\bar{I}^L)} [\hat{I}_{t+1}^R - E_t(\hat{I}_{t+1}^R)] + \frac{q(1+\bar{I}^L)}{(1+\bar{r}^K)(1+\pi^S)} [\hat{P}_{t+1}^S -$
 $E_t(\hat{P}_{t+1}^S)]$
10. $\beta\hat{\pi}_{t+1}^D = \hat{\pi}_t^D - \frac{(\theta_D-1)}{\phi} \widehat{MC}_t + \beta\mu^F[\hat{\pi}_{t+1}^D - E_t(\hat{\pi}_{t+1}^D)]$
11. $\frac{(\bar{I}^R - \bar{I}^w)}{1+\bar{I}^R} \hat{L}_t^{F,B} = \hat{I}_t^R - \hat{I}_t^w - [\hat{E}_{t+1} - \hat{E}_t - (\hat{E}_{t+1} - E_t(\hat{E}_{t+1}))]$
12. $\hat{I}_{t+1}^w = \rho_w\hat{I}_t^w + \hat{\xi}_t^w$

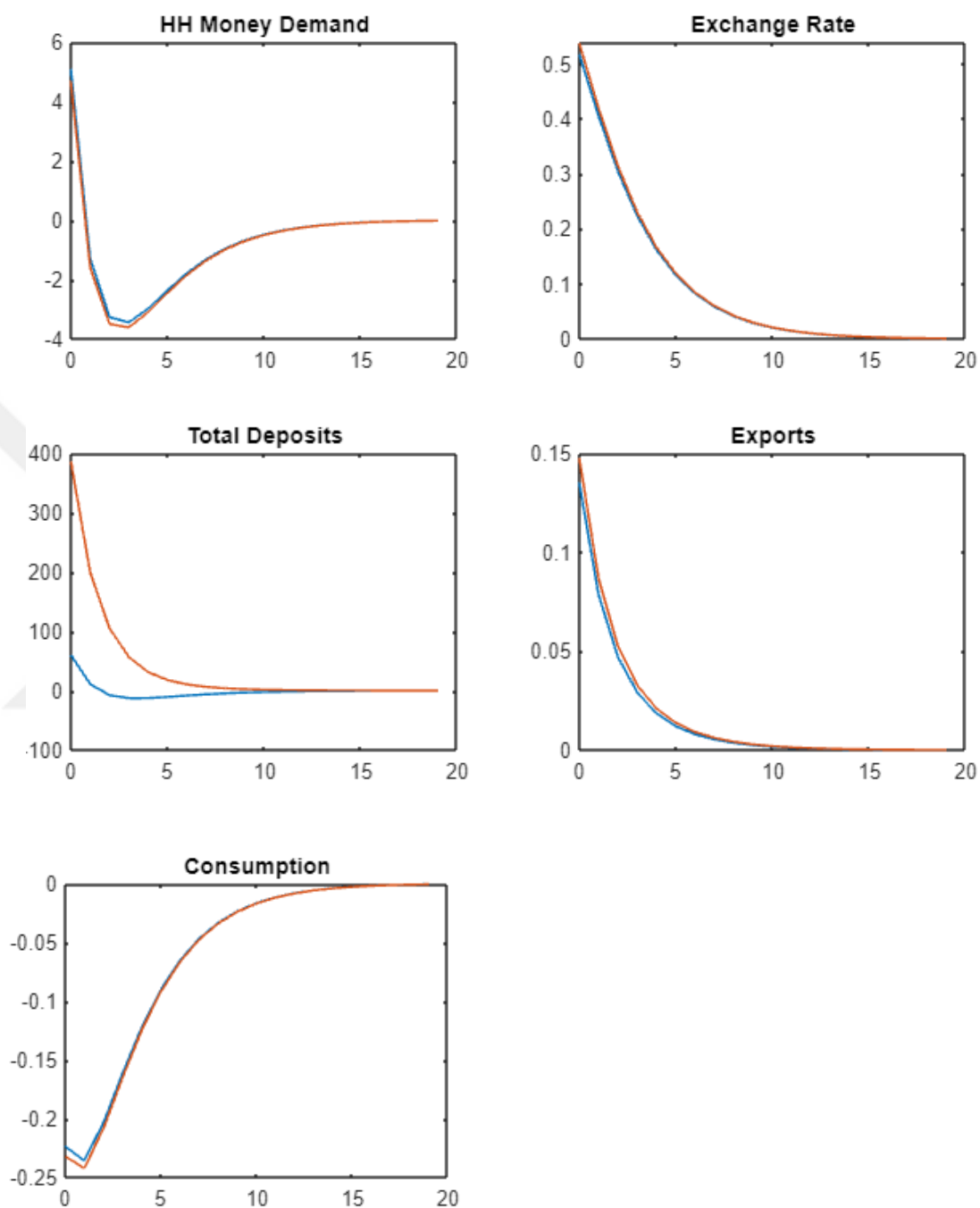
Appendix C. Impulse Response Functions

1. IRFs for Increase in Worldwide Riskless Interest Rate

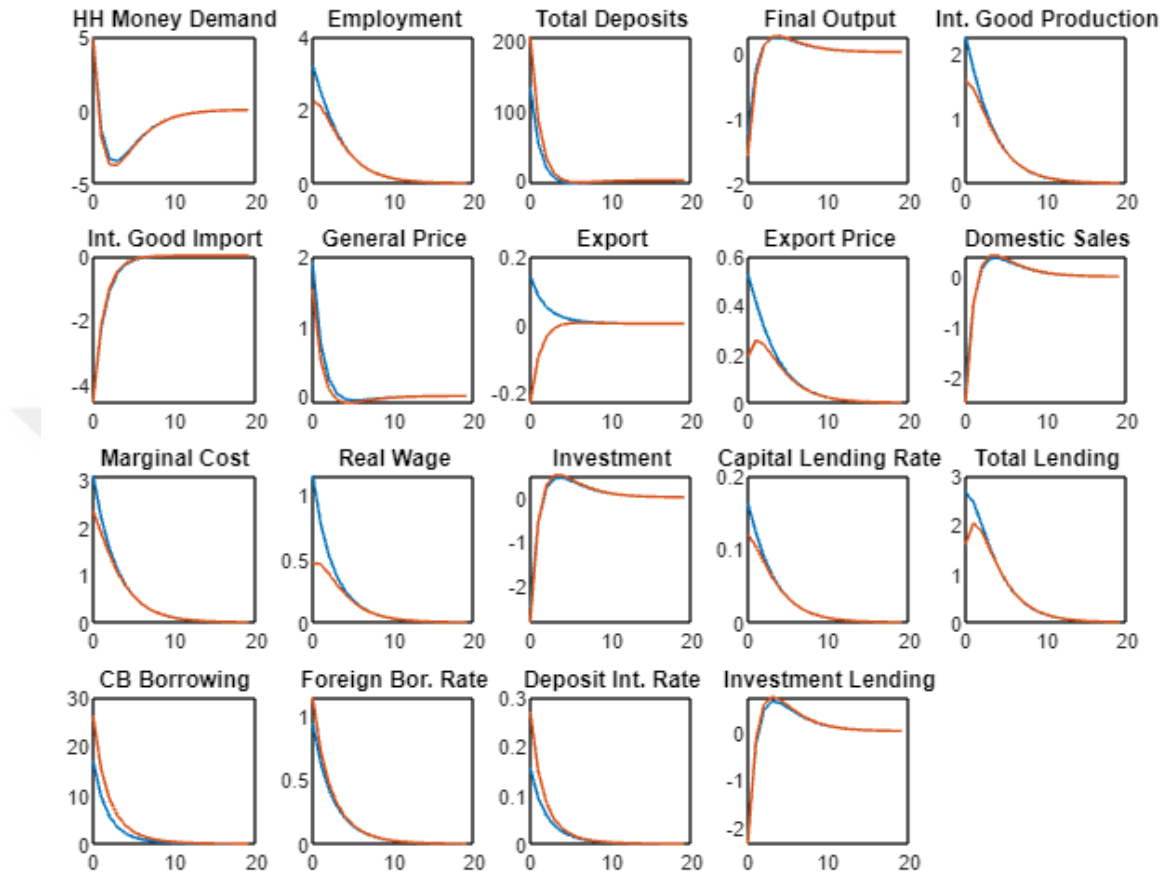


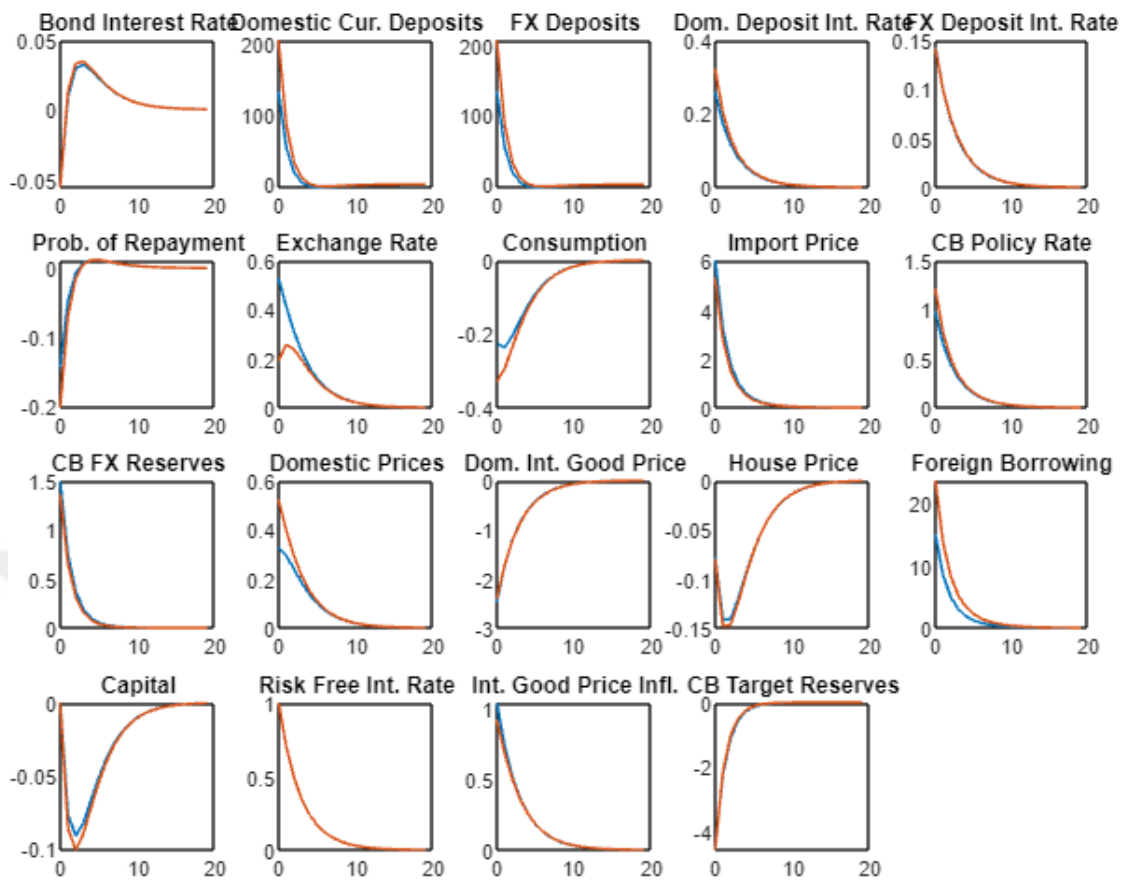


2. IRFs for Increase in Worldwide Riskless Interest Rate with 0.8 (blue lines) and 0.2 (orange lines) Dollarization Rate



3. IRFs for Increase in Worldwide Riskless Interest Rate with 2 (blue lines) and 4 (orange lines) as Coefficient of Imports in Reserve Target





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Hazırlayanın Adı Soyadı : Kadriye Nur ARSLAN
Tez Başlığı : Effects of Financial Dollarization on The Impact of
Interest Rate Shock: A New Keynesian DSGE Model for Türkiye
Savunma Tarihi : 29/ 08 / 2023
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