# Tradable and Nontradable Inflation in Turkey: Predicting Different States with Markov Regime-Switching Approach 

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# Tradable and Non-tradable Inflation in Turkey: Predicting 

# Different States with Markov Regime-Switching Approach 

Hülya Saygilı* Aysun Türkvatan ${ }^{\dagger}{ }^{\dagger+}$


#### Abstract

The recent literature debates the significance of different regimes of inflation and trade linkages in explaining the relationship between inflation and alternative reference indicators. This paper contributes to this literature in several respects. First, it explores which states of the reference indicators are more related with low, normal or high regimes of inflation. Second, it takes globalization into account and performs the analysis for goods and services in the consumer basket classified with respect to their trade openness and content of intermediate imports: tradable/nontradable items and items with low/high imported intermediate share. It applies Markov regimeswitching models to determine the states of inflation and reference series then compare probability scores of matching different regimes of inflation and different regimes of reference indicators. Third, it computes Consumer Price Indices in tradable/non- tradable and low/high imported intermediate details for an emerging country, Turkey which distinguishes from the others with high trade openness, high global integration rate and implementation of inflation targeting regime.


Keywords: Inflation regimes, Tradable/non-tradable inflation, Markov regime-switching models, Probability score analysis

JEL codes: E31, F41, C11

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## Non-Technical Summary

Economic agents want to predict inflation dynamics by monitoring developments of a set of reference indicators in order to make their decisions about consumption, saving and production. However, by stimulating cross-country inflationary linkages, globalization complicates the decision process. The importance of factors on inflation may vary depending on the state of the inflation as well the states of the reference series.

This paper explores if it is possible to monitor domestic inflation by using the information contained in a set of reference indicators. Inflation as well as each of the reference series are assumed to be governed by a regime-switching process, in which they can switch between low, normal and high regimes. Then, probability scores for matching inflation with each reference indicator are computed to find out which regime of inflation is most related to which regime of the reference indicator. For instance, we can match high regime of inflation with low, normal and high regimes of exchange rates one by one and compare probability scores to conclude which regime of exchange rate is more related with high inflation regime. This approach is new in this literature.

The other contribution to the literature is related to the examination of consumer price index for goods and services classified separately with respect to their trade openness: tradable and non-tradable consumer goods and services. Following Dixon et al. (2004) and Johnson (2017) methodology and using items classified in 4-digit Harmonized System, price indices for tradable and non-tradable items are computed for Turkey. As another contribution, using input-output tables, items are further classified according to the imported intermediate content ratio.

Overall, the results support the view that the relationship between reference indicators and inflation changes depending on the regime of inflation. The exchange rates and export to import volume ratio stand out as the main reference indicators associated with the pace of inflation in Turkey. High regimes of exchange rates and export to import volume ratio are strongly associated with high regime of inflation. Exclusion of energy-related items does not affect the relationship between high regimes of all types of inflation and high regimes of exchange rates. The association between inflation and reference indicators changes depending on the trade structure. The high regime of exchange rates and export to import volume ratio better predict the acceleration in tradable inflation. These cost indicators are more closely related to the inflation of items with high intermediate imports, especially non-tradable items with high intermediate import content.

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#### Abstract

The recent literature debates the significance of different regimes of inflation and trade linkages in explaining the relationship between inflation and alternative reference indicators. This paper contributes to this literature in several respects. First, it explores which states of the reference indicators are more related with low, normal or high regimes of inflation. Second, it takes globalization into account and performs the analysis for goods and services in the consumer basket classified with respect to their trade openness and content of intermediate imports: tradable/non-tradable items and items with low/high imported intermediate share. It applies Markov regime-switching models to determine the states of inflation and reference series then compare probability scores of matching different regimes of inflation and different regimes of reference indicators. Third, it computes Consumer Price Indices in tradable/nontradable and low/high imported intermediate details for an emerging country, Turkey which distinguishes from the others with high trade openness, high global integration rate and implementation of inflation targeting regime.


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## 1 Introduction

Economic agents would like to know the direction of inflation in advance to make their decisions about consumption, saving and production. They want to predict inflation dynamics by monitoring developments of a set of reference indicators. However, globalization in both goods and financial markets raises important challenges to decision makers by connecting domestic economies to global dynamics. That has made the inflationary linkages to become one of the most debated issues in recent years.

In line with the debate, this paper contributes to the literature by exploring the association between the regimes, in other words low, normal or high regimes, of the reference indicators and of inflation. Accordingly, our empirical analysis consists of two main parts. In the first part, we develop Markov regime-switching (MS) models for inflation and reference series to find out their low, normal and high regimes. In the second part, we examine the probability scores of matching between different regimes of inflation and different regimes of reference indicators.

The question that whether the importance of factors on inflation may vary depending on the state of the inflation is not new. Taylor (2000), for instance, hypothesized that exchange rate pass-through is positively correlated with the rate of inflation. Stock \& Watson (2007) for the US and Fischer et al. (2006) for the euro area show the difficulty in forecasting inflation due to the weakening linkage between inflation and a range of leading indicators including money growth for the years characterized by relatively low and stable inflation. Benati (2008) documents that low inflation regimes have very different statistical properties than high inflation regimes. Some studies such as Dong (2012), Marazzi \& Sheets (2007) and Gust et al. (2010) attribute the decline to the increasing trade integration, global markets competition and changes in pricing in advanced economies, while some others, such as Brazier et al. (2018) relate it to the implementation of inflation targeting regimes as it makes inflation muted to shocks by strongly anchoring inflation

[^1]expectations.
MS models, extensively used in business cycle analysis, also take great attention for modeling inflation in which inflation rate is ruled by a regime-switching process; shifts from regime of low to high inflation and/or vice versa, to investigate the properties of inflation in different regimes. Baharumshah et al. (2017), Abiad (2003) and Amisano \& Fagan (2013) support that the linkage between inflation and reference indicators may vary with respect to the state of the inflation regime. In contrast to the standard MS models, Abiad (2003) and Amisano \& Fagan (2013) allow transition probabilities to depend on some leading indicators. In this paper, we take up this debate and investigate the relationship between inflation and other related reference indicators using Markov-switching modeling. Different from them, instead of characterizing inflation by two regimes, we let the model to detect regimes of low, normal and high inflation. We also do this for each reference indicator.

Taking the globalization issues into consideration, our main contributions to the literature are related with the examination of Consumer Price Index (CPI) for goods and services classified with respect to their trade openness. ${ }^{1}$ Trade theory argues that intensive competition between domestic and foreign suppliers allows tradable goods prices to be set below the non-tradable goods prices, meantime making prices of these goods and services more sensitive to the global conditions. Due to that it is widely admitted among the economists that CPI inflation must be monitored in two classifications: tradable and non-tradable consumer goods and services inflation.

The literature does not provide sufficient number of work on the classification of CPI in tradable and non-tradable components. Among the few, De Gregorio et al. (1994) for 14 OECD countries, Dixon et al. (2004) for New Zealand, Johnson (2017) for the United States (US) and Piton (2017) for 11 European Union countries show that although both indices follow a similar path, tradable goods price index tends to go below the non-tradable goods price index. ${ }^{2}$ The asymmetric response of tradable and non-tradable consumer price inflation to the changes in exchange rate in particular is reported in Hobijn et al. (2019), Gerstein et al. (2019) and García-Cicco \& GarcíaSchmidt (2020). Hobijn et al. (2019) and Gerstein et al. (2019), using input-output tables and the classification of tradable and non-tradable items in Allington et al. (2005) note that, in case of the United Kingdom, the exchange rate pass-through to tradable items with high import content is more than that of non-tradable items with low import content. García-Cicco \& García-Schmidt (2020) investigate alternative specifications of baseline model including pricing differences and invoicing currency for tradable items and show that conditional exchange rate pass-through to prices of tradable items is always higher than that of non-tradable items in Chile. ${ }^{3}$

In this study, we follow Dixon et al. (2004) and Johnson (2017) methodology and use items classified in 4-digit Harmonized System in computing price indices for tradable and non-tradable goods and services in consumer basket. We computed the price indices using data for Turkey. Hence, these indices would be computed for the first time for an emerging country. We focused on a single country and included only those items in the official consumer basket. This allowed us to use the official weights as well as price of the items in the consumer basket when aggregating new indices. Thus, the overall index is comparable to the official CPI index published by the Turkish Statistics Institute. Hence, we can analyze how differently new indices behave compared to the official one. ${ }^{4}$

Turkish case would be interesting for several reasons. First, Turkey, an emerging country, has been implementing formal inflation targeting regime since 2006. Second, among the emerging countries Turkey has an above the average trade openness ratio. ${ }^{5}$ Third, Turkey also outperforms many emerging countries in integrating global production chains. ${ }^{6}$ To take the effect of global

[^2]production chains into account, as another contribution to the literature, we further disaggregate goods and services with respect to their imported intermediary content, a widely accepted indicator used to measure the extent of production integration. Then we conduct MS and matching analysis using these new indices.

The debate about the role of global production chains on the domestic inflation dynamics is also not new. For instance Goldberg \& Campa (2010) and Abdelmalack \& Campos (2020) have focused on the role of imported inputs in the exchange rate pass-through channel. Goldberg \& Campa (2010) analyze 21 OECD economies and conclude that the imported inputs channel of exchange rate pass-through is more important than the imported consumption goods channel. Abdelmalack \& Campos (2020) analyze 5 advanced economies (Australia, France, Germany, Portugal and US) and an emerging economy (Brazil) and conclude that the share of tradable items and the share of imported inputs in the consumption basket have a key role in the exchange rate pass-through channel.

Studies for Turkey also indicate changing relationship between inflation and leading indicators. A part of this is explained by the implementation of inflation targeting policy. Yüncüler (2011) notes that the degree of pass-through is significantly lower in the inflation targeting period compared to the previous period. Given the implementation of inflation targeting regime, Tunç (2017) argue that the level of inflation give rise to asymmetric behavior of exchange rate pass-through to prices, Atabay (2016) finds a negative correlation between trade openness and inflation rate, while Çiçek (2012) shows that globalization has more influence on tradable (goods) inflation than on overall inflation (goods and services). Saygılı \& Saygılı (2011) and Saygılı \& Saygılı (2019) study the changing relationship between inflation and exchange rates depending on the degree of integration to global value chains. ${ }^{7}$

A set of reference indicators including alternative exchange rates are analyzed to find out their relationship with inflation. Similar to inflation, each of them are assumed to be governed by a regime-switching process, in which they can switch between low, normal and high regimes. Then, we compute probability scores for matching inflation with each reference indicator to find out which regime of inflation is most related to which regime of the reference indicator. For instance, we can match high regime of inflation with low, normal and high regime of exchange rates one by one and compare probability scores to conclude which regime of exchange rate is more related with high inflation regime. This approach is also new in this literature. Following this procedure lets us to examine the relationship between inflation and reference indicators in more detail.

Overall, our results support the view that the relationship between reference indicators and inflation changes depending on the regime of inflation. High regimes of exchange rates and export to import volume ratio are detected as the main reference indicators of high regime of inflation in Turkey. Exclusion of energy-related items does not affect the relationship between high regimes of all types of inflation and high regimes of exchange rates. The association between inflation and reference indicators changes depending on the trade structure. The high regime of exchange rates and export to import volume ratio better predict the acceleration in tradable inflation. These cost indicators are more closely related to the inflation of items with high intermediate imports, especially non-tradable items with high intermediate import content.

The rest of the paper is structured as follows. Section 2 explains the computation of CPI for different classifications of goods and services and reports some statistics about the new inflation series. MS models for inflation series and results from the analysis are given in Section 3. Section 4 examines the matching properties of different inflation regimes and regimes of reference series via probability score analysis. Final section provides further results and concludes the analysis.

[^3]
## 2 Computing Price Indices: Methodology and Data

### 2.1 Methodology

The first step in creating tradable and non-tradable price indices is to determine which goods and services in the consumer basket fall into each category and then aggregate them on the basis of their tradability classification. We follow Dixon et al. (2004) and Johnson (2017) approaches to construct price indices for different categories of goods and services. The analysis consists of three stages. In the first stage, a threshold is set for the tradability criteria. In the second stage, goods and services that meet the determined threshold is detected using Input-Output (IO) tables. In the third stage, using those classifications, goods and services are aggregated to create the indices.

One of the problems in constructing of tradable and non-tradable inflation series is the usage of different classification of goods and services in calculating the consumer price index (item-based) and in creating input-output tables (sector-based). These two classifications must be appropriately matched to set up a reliable analysis. Eurostat corresponding tables are used to determine which goods and services in consumer basket belong to which sectors in input-output tables. ${ }^{8,9}$

IO tables include information about the sectoral production, exports, imports and even the usage of imported inputs. Using these information it is possible to compute several ratios to compare sectors' trade structure. Sectoral trade openness is computed as a ratio of sum of sectoral imports and exports to sectoral total supply. Sectors with trade openness ratio above a threshold is called tradable sector, and goods and services belong to those sectors are classified as tradable items.

In determining the threshold, for different threshold values, we observe the number of products changing the category of tradability if this value is increased or decreased by 1 point. ${ }^{10}$ The ratio causing the least number of changes is chosen as the optimal threshold value. For example, when a threshold value is selected as 9 percent, products with an openness ratio above this value are called tradable goods. When this threshold value is increased to 10 percent, products with the openness ratio between 9 to 10 percent will gain the status of non-tradable goods and services. The optimal threshold value is determined as the ratio in which these changes are the least.

Also, using IO tables we can compute imported intermediate content of each sector as a ratio of intermediate imports over the total intermediate used to further investigate the trade structure of each sector. Sectors that have a ratio above (below) a threshold value are called sectors with high (low) intermediate import content.

The analysis covers items in 2020 consumer basket of Turkey for the period between January 2003 and September 2020. According to the 4 -digit product classification, there are 91 different types of products in 2020 consumer basket. The current IO tables are available for 2012 for Turkey. Hence, 91 products are matched with 38 sectors in the tables.

Firstly, from the 2012 IO analysis the optimal threshold value for the trade openness ratio is computed as 14 percent and good and services with the ratio above (below) 14 percent are classified as tradable (non-tradable). However, thresholds are taken judgmentally as 10 percent in studies that conduct sector level analysis, ${ }^{11}$ while in Dixon et al. (2004) and Johnson (2017), it was calculated as 15 and 11 percent, respectively. Secondly, the optimal threshold value for the imported intermediate content ratio is computed as 17 percent: Goods and services having the ratio above (below) 17 percent are classified as items with high (low) intermediate import content. It is also possible to further disaggregate tradable goods and services according to their imported intermediate content.

In the calculation of the official CPI $(2003=100)$, announced monthly by Turkish Statistical Institute (TurkStat), weights of the items in the consumer basket change from year to year while

[^4]aggregating prices. The weights are publicly available from TurkStat as of 2012. However, starting the period from 2012 is not producing sufficient number of observations for us to set up a reliable empirical analysis. Alternatively, we use current publicly available 2020 product weights in the computation of our indices. The usage of fixed weights, on the one hand, allows us to generate monthly observations from 2003 to 2020 , smooth out the weight effects from the indices and focus on the effects of product prices. On the other hand, it is difficult to compare our aggregate CPI, in particular, one to one with TurkStat aggregate CPI. However, since our ultimate objective is not the reproduction of TurkStat CPI index, but to investigate the impact of trade factor on the relationship between domestic price changes and a set of reference indicators, we opt to proceed with fixed weights.

### 2.2 Data

## Structure of the Consumer Basket

In addition to the aggregate index we computed new price indices with respect to their trade structure. Different principles may be used for classification of sectors as tradable/non-tradable. Tables 1 and 2 compare how the classification of sectors changes if different principles were used, including export/supply, import/supply, trade volume/supply and intermediate imports/total intermediate ratios, in the analysis. The number of sectors and their total weight in the tradable classification reach the highest level when export/total supply ratio is used as criteria. According to the export/total supply ratio, 18 sectors are included in tradable classification. Majority of them ( 15 sectors) are listed as tradable when the trade volume/total supply ratio is used instead of export/total supply ratio. The total weight of the three sectors not included in tradable classification according to the trade volume/total supply criteria is 4.48 percent, and land transport services has the highest weight among them with 3.05 percent. Products of agriculture, with the weight of 5.72 percent, have the fifth highest weight in the consumer basket. It is listed in tradable classification only when import/total supply criteria is used.

For the tradable/non-tradable classification of goods and services, we use the trade volume, that is the sum of exports and imports, over the total supply as an indicator of trade openness. This criteria not only reflects common exports and imports dynamics, but also it is a widely used main indicator for trade openness. ${ }^{12}$ Accordigly, tradable items have a weight of about 57 percent in the consumer basket (Table 1). The majority of these items ( 31.4 points) use imported intermediates above the threshold value of 17 percent. Items belonging to food, beverages and tobacco products account for the highest weight in the consumer basket, and are classified as tradable products with low intermediate import ratio. Products registered in textiles, wearing apparel etc., motor vehicles etc. and coke etc. also have significant weights in the consumer basket, but these tradable products have high intermediate import ratio.

[^5]Table 1: Trade openness and imported intermediate shares obtained from input-output tables for tradable sectors (\%).

|  |  |  |  | Threshold=14 | Threshold=17 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Sector | Consumer basket weight | Export / <br> Total supply* | Import / <br> Total supply** | $\begin{gathered} \text { Trade volume / } \\ \text { Total } \\ \text { supply } \\ \hline \end{gathered}$ | Inter. import / Total inter. |
| Tradable with high intermediate import | 31.37 |  |  |  |  |
| Textiles, wearing apparel, leather and related products | 7.995 | 32.13 | 9.90 | 42.03 | 18.17 |
| Motor vehicles, trailers and semi-trailers | 5.991 | 33.26 | 35.34 | 68.61 | 36.43 |
| Coke and refined petroleum products | 5.277 | 15.09 | 46.14 | 61.23 | 72.91 |
| Furniture and other manufactured goods | 4.171 | 15.57 | 16.02 | 31.59 | 20.41 |
| Chemicals and chemical products | 2.792 | 12.14 | 53.16 | 65.30 | 44.88 |
| Electrical equipment | 2.191 | 30.87 | 31.35 | 62.22 | 30.25 |
| Computer, electronic and optical products | 1.756 | 16.06 | 66.12 | 82.18 | 40.86 |
| Basic pharmaceutical products and pharmaceutical preparations | 0.717 | 9.41 | 49.16 | 58.57 | 34.22 |
| Other transport equipment | 0.275 | 22.59 | 57.68 | 80.27 | 30.22 |
| Paper and paper products | 0.201 | 11.27 | 25.37 | 36.64 | 37.93 |
| Tradable with low intermediate import | 25.83 |  |  |  |  |
| Food, beverages and tobacco products | 22.852 | 9.70 | 5.99 | 15.69 | 14.80 |
| Other non-metallic mineral products | 2.245 | 12.61 | 5.78 | 18.38 | 15.32 |
| Warehousing and support services for transportation | 0.463 | 13.32 | 12.65 | 25.97 | 10.27 |
| Insurance, reinsurance and pension funding services, except compulsory social security | 0.238 | 10.66 | 9.29 | 19.96 | 14.73 |
| Water transport services | 0.030 | 37.65 | 0.73 | 38.37 | 15.36 |
| Tradable | 57.19 |  |  |  |  |

* : If the ratio of export to total supply is below Threshold $=6$, it is written in bold. This implies nontradability with respect to this criteria.
${ }^{* *}$ : If the ratio of import to total supply is below Threshold $=7$, it is written in bold. This implies nontradability with respect to this criteria.

In the consumer basket, the weight of non-tradable items is about 43 percent (Table 2). Unlike tradable items, the majority of non-tradable group (39 points) consists of goods and services with intermediate import ratio below the threshold. This is plausible as non-tradable items mainly consists of services items. Except for electricity, gas etc., wholesale and retail trade, as well as repair services, all services items have intermediate import ratio below the threshold value of 17 percent.

Table 2: Trade openness and imported intermediate shares obtained from input-output tables for non-tradable sectors (\%).

|  |  |  |  | Threshold=14 | Threshold=17 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Sector | Consumer <br> basket weight | Export Total supply* | Import / Total supply** | Trade volume / Total supply | Inter. import/ <br> Total inter. |
| Nontradable with high inter. import | 3.75 |  |  |  |  |
| Electricity, gas, steam and air conditioning | 2.359 | 0.28 | 0.38 | 0.66 | 27.24 |
| Wholesale and retail trade and repair services of motor vehicles and motorcycles | 1.072 | 0.00 | 0.00 | 0.00 | 17.94 |
| Repair services of computers and personal and household goods | 0.323 | 0.00 | 0.00 | 0.00 | 22.77 |
| Nontradable with low inter. import | 39.05 |  |  |  |  |
| Accommodation and food services | 8.668 | 1.89 | 1.67 | 3.55 | 9.33 |
| Products of agriculture, hunting and related services | 5.722 | 4.95 | 7.41 | 12.36 | 14.03 |
| Real estate services excluding imputed rents | 4.998 | 0.00 | 0.00 | 0.00 | 16.12 |
| Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services | 4.577 | 0.31 | 2.32 | 2.63 | 14.33 |
| Land transport services and transport services via pipelines | 3.046 | 9.63 | 0.20 | 9.83 | 13.92 |
| Telecommunications services | 2.946 | 0.29 | 0.62 | 0.91 | 4.70 |
| Education services | 2.837 | 0.00 | 0.00 | 0.00 | 6.15 |
| Human health services | 1.861 | 0.17 | 0.02 | 0.18 | 13.18 |
| Travel agency, tour operator and other reservation services and related services | 1.060 | 7.34 | 5.86 | 13.20 | 11.70 |
| Other personal services | 0.718 | 0.01 | 0.07 | 0.08 | 14.25 |
| Legal and accounting services; services of head offices; management consulting services | 0.625 | 0.07 | 1.01 | 1.08 | 7.26 |
| Services of households as employers; undifferentiated goods and services produced by households for own use | 0.606 | 0.00 | 0.00 | 0.00 | 0.00 |
| Publishing services | 0.375 | 2.32 | 8.80 | 11.12 | 10.61 |
| Fish and other fishing products; aquaculture products; support services to fishing | 0.375 | 8.69 | 2.53 | 11.23 | 11.61 |
| Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services | 0.361 | 0.52 | 12.98 | 13.50 | 15.48 |
| Residential care services; social work services without accommodation | 0.202 | 0.00 | 0.00 | 0.00 | 9.64 |
| Creative arts, entertainment, library, archive, museum, other cultural services; gambling and betting services | 0.040 | 0.02 | 0.53 | 0.56 | 4.06 |
| Other professional, scientific and technical services and veterinary services | 0.028 | 0.14 | 1.03 | 1.17 | 14.01 |
| Financial services, except insurance and pension funding | 0.005 | 2.67 | 3.70 | 6.37 | 4.45 |
| Postal and courier services | 0.001 | 1.88 | 1.00 | 2.87 | 8.25 |
| Nontradable | 42.81 |  |  |  |  |

* : If the ratio of export to total supply is above Threshold=6, it is written in bold. This implies tradability with respect to this criteria.
** : If the ratio of import to total supply is above Threshold=7, it is written in bold. This implies tradability with
respect to this criteria.

Accordingly, Table 3 summarizes that total weight of the goods and services with low (high) intermediate imports in 2020 consumer basket is about 65 (35) percent. ${ }^{13}$ Additionally, more than

[^6]half of the tradable items have a high intermediate import ratio, while almost all items in the non-tradable items have a low intermediate import ratio. Moreover, 89 percent of the goods and services with high intermediate import ratio consists of tradable items, while non-tradable items constitutes about 60 percent of goods and services with low intermediate import ratio (Table B. 2 in Appendix B.).

Table 3: The consumer basket weights for tradable/nontradable sectors with high/low intermediate import content (\%).

|  | Tradable | Nontradable | Total |
| :--- | :---: | :---: | :---: |
| High intermediate import | 31.37 | 3.75 | 35.12 |
| Low intermediate import | 25.83 | 39.05 | 64.88 |
| Total | 57.19 | 42.81 | 100.00 |

## Trends in Price Indices and Basic Statistics for Inflation Series

Trade theory posts that by intensifying competition among domestic and foreign firms, on average, prices of tradable items can be set at a lower level than prices of non-tradable items. Figure 1 verifies the predictions and shows that price index of tradable items lies below that of non-tradable items. Among the tradable goods and services prices for those including high intermediate imports are set below those including low intermediate imports. Figure 1 further shows that this pricing behavior also exists for goods and services with high intermediate import and low intermediate imports. This may be explained with the contractual relationship in backward-forward international production linkages in these sectors.


Figure 1: Relative indices.
Notes: Relative indices are obtained by multiplying the ratio of the price indices by 100 .

Basic statistics about the inflation rates are given in Table 4. The first three rows show that when the whole period is considered, the mean of non-tradable inflation tends to be above that
of overall inflation, while the mean of tradable inflation is below it. However, in last three years, prices of tradable items have exhibited a higher rate of growth than those of non-tradable items. Tradable inflation shows a more volatile pattern, but in the last years non-tradable inflation exhibited a higher variation, implying that domestic inflationary factors to be more effective on driving the volatility in overall inflation. On the other hand, the mean price increase is relatively lower for items with high intermediate imports compared to that with low intermediate imports, except the last three years. Also, Table 4 reports a higher mean inflation for tradable items with low intermediate imports than that with high intermediate imports. Hence, it may be concluded that the higher pace of increases in prices can be linked to the increasing rate in inflation of the imported intermediate items.

Table 4: Descriptive statistics.

| Inflation group | Period | Mean | Standard <br> deviation | Coefficient <br> of variation | Minimum | Maximum |
| :--- | :--- | :---: | :---: | :---: | :---: | :---: |
|  | $2004-2020$ | 9.78 | 3.33 | 34.08 | 4.39 | 25.09 |
| Overall | $2015-2020$ | 12.00 | 4.45 | 37.06 | 6.90 | 25.09 |
|  | $2017-2020$ | 14.14 | 4.10 | 28.97 | 9.86 | 25.09 |
|  | $2004-2020$ | 9.36 | 4.07 | 43.53 | 1.84 | 27.75 |
| Tradable | $2015-2020$ | 12.48 | 4.91 | 39.36 | 4.90 | 27.75 |
|  | $2017-2020$ | 14.94 | 4.24 | 28.35 | 8.94 | 27.75 |
|  | $2004-2020$ | 10.35 | 3.33 | 32.16 | 4.04 | 21.77 |
| Nontradable | $2015-2020$ | 11.37 | 4.35 | 38.31 | 4.50 | 21.77 |
|  | $2017-2020$ | 13.07 | 4.36 | 33.34 | 7.75 | 21.77 |
| High | $2004-2020$ | 8.24 | 5.23 | 63.45 | -1.08 | 34.13 |
| intermediate | $2015-2020$ | 11.59 | 6.66 | 57.47 | 2.13 | 34.13 |
| import | $2017-2020$ | 14.53 | 6.39 | 43.97 | 3.72 | 34.13 |
| Low | $2004-2020$ | 10.63 | 3.07 | 28.92 | 3.16 | 20.81 |
| intermediate | $2015-2020$ | 12.24 | 3.88 | 31.70 | 6.76 | 20.81 |
| import | $2017-2020$ | 13.95 | 3.75 | 26.91 | 8.57 | 20.81 |
| Tradable | $2004-2020$ | 7.88 | 5.48 | 69.63 | -1.68 | 35.38 |
| with high | $2015-2020$ | 11.66 | 6.90 | 59.19 | 1.97 | 35.38 |
| inter. import | $2017-2020$ | 14.50 | 6.85 | 47.26 | 2.30 | 35.38 |
| Tradable | $2004-2020$ | 11.18 | 4.09 | 36.53 | 1.99 | 25.17 |
| with low | $2015-2020$ | 13.51 | 4.59 | 34.00 | 8.29 | 25.17 |
| inter. import | $2017-2020$ | 15.52 | 4.47 | 28.79 | 9.24 | 25.17 |

## 3 Empirical Analysis: Markov Regime-Switching Models

### 3.1 Methodology

Hamilton (1989) argues that since the dynamics of recessions differ from those of expansions, the growth of real gross national product can be modeled as a 2-state MS model. ${ }^{14}$ According to Nelson \& Kim (1999), MS models can capture a particular form of nonlinear dynamics or asymmetry in fluctuations of any variable. This is mainly due the fact that the switching mechanism between the regimes is governed by an unobserved (latent) Markov chain. There are also threshold type regime-switching models such as threshold autoregressive (TAR) model proposed by Tong (1983), see Franses \& Van Dijk (2000). The main difference between threshold type regime-switching models and MS models is that in case of the former, the switching mechanism between the regimes is observable, while in case of the latter, it is latent. MS models allow the model parameters to change when a regime switch occurs and formally summarized as ${ }^{15}$

$$
\begin{equation*}
Y_{t}=\alpha_{\zeta_{t}}+\sigma_{\zeta_{t}}^{2} \epsilon_{t} \tag{1}
\end{equation*}
$$

where $\epsilon_{t} \sim \mathcal{N}(0,1)$. Here, $\zeta_{t}$ is an $N$-state Markov chain with transition matrix $\mathbf{P}=\left(p_{j i}\right)_{i, j=1, \ldots, N}$,

[^7]where $p_{j i}=\mathbb{P}\left[\zeta_{t+1}=j \mid \zeta_{t}=i\right]$ and each column of $\mathbb{P}$ sums to unity. Note that $p_{j i}$ gives the probability of switching from state $i$ at time $t\left(\zeta_{t}=i\right)$ to state $j$ at time $t+1\left(\zeta_{t+1}=j\right)$. Notice that $\alpha$ represents the mean level and $\sigma$ is the volatility, both of which depend on the chain $\zeta_{t}$.

Using Equation 1, we consider the following four types of MS models:

- Model 1: 2-state MS model with changing mean and constant variance,
- Model 2: 2-state MS model with changing mean and changing variance,
- Model 3: 3-state MS model with changing mean and constant variance,
- Model 4: 3 -state MS model with changing mean and changing variance.

The estimation of MS models is performed using maximum likelihood method as in Perlin (2015). The adequacy of the number of regimes is determined using the quality of regime classification measure suggested in Ang \& Bekaert (2002). The Regime Classification Measure (RCM) is defined for $N$-state as,

$$
\begin{equation*}
R C M=100 N^{2} \frac{1}{T} \sum_{t=1}^{T} \prod_{j=1}^{N} p_{j, t} \tag{2}
\end{equation*}
$$

where $p_{j, t}=\mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{\mathrm{T}}\right]$ is the smoothed probability. The RCM takes values between 0 and 100 . The RCM value of 0 is associated with perfect regime classification while the RCM value of 100 means that no information about the regimes is revealed. Thus, the lower the RCM values, the better the quality of regime classification.

### 3.2 Estimation Results of Markov Regime-Switching Models

We model the dynamics of each inflation series using MS models and use RCM criteria to determine the adequacy of the switches. The RCM analysis supported modeling the inflation for overall, tradable, high intermediate imports and tradable with low intermediate imports by a 3 -state MS model with changing mean and constant variance; for tradable with high intermediate import by a 3 -state MS model with changing mean and changing variance; for non-tradable and low intermediate import by a 2 -state MS model with changing mean and constant variance. ${ }^{16} 3$-states represent normal, low and high regimes while 2 -states represent low and high regimes.

Table 5 reports the proposed MS models for each inflation series. Mean values with their variance for each regime are given in Columns 4 and 5 , respectively, while transition probability matrix $\mathbf{P}=\left(p_{j i}\right)_{i, j=1,2,3}$, is reported in Columns 6 to 8 . For overall inflation, probability of staying in normal regime in the next period, given that the process is in normal regime in the current period is $p_{11}=0.90$, which implies that normal regime is persistent. Probabilities of switching to low and high regimes from normal regime are $p_{21}=0.10$ and $p_{31}=0.01$, respectively. The probability of staying in low regime is $p_{22}=0.94$, which implies that low regime is highly persistent, while the probability of switching to normal regime from low regime is $p_{12}=0.05$. Furthermore, the probability of staying in high regime is $p_{33}=0.85$, indicating persistency, while, probabilities of switching to normal and low regimes from high regime are $p_{13}=0.09$ and $p_{23}=0.07$, respectively.

[^8]Table 5: Proposed MS models for inflation of various groups.

| Inflation group | Regime | State | Mean | Variance | $p_{j 1}$ | $p_{j 2}$ | $p_{j 3}$ | Expected <br> duration |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |
| Overall | Normal | State 1 | 11.00 | 1.92 | 0.90 | 0.05 | 0.09 | 9.63 |
|  | Low | State 2 | 7.98 | 1.92 | 0.10 | 0.94 | 0.07 | 17.33 |
|  | High | State 3 | 19.43 | 1.92 | 0.01 | 0.01 | 0.85 | 6.50 |
| Tradable | Low | State 1 | 7.24 | 3.29 | 0.98 | 0.05 | 0.00 | 44.20 |
|  | Normal | State 2 | 12.19 | 3.29 | 0.02 | 0.93 | 0.07 | 15.04 |
|  | High | State 3 | 20.18 | 3.29 | 0.00 | 0.02 | 0.93 | 14.34 |
| Nontradable | High | State 1 | 13.27 | 5.38 | 0.97 | 0.02 |  | 37.52 |
|  | Low | State 2 | 8.42 | 5.38 | 0.03 | 0.98 |  | 58.54 |
| High inter. | Normal | State 1 | 10.56 | 7.36 | 0.91 | 0.05 | 0.00 | 11.35 |
|  | Low | State 2 | 5.40 | 7.36 | 0.07 | 0.95 | 0.07 | 18.73 |
|  | High | State 3 | 21.65 | 7.36 | 0.02 | 0.00 | 0.93 | 14.70 |
| Low inter. import | High | State 1 | 16.62 | 4.18 | 0.93 | 0.01 |  | 13.74 |
|  | Low | State 2 | 9.75 | 4.18 | 0.07 | 0.99 |  | 172.41 |
| Tradable with | Normal | State 1 | 7.74 | 1.72 | 0.88 | 0.11 | 0.03 | 8.69 |
|  | Low | State 2 | 3.51 | 3.29 | 0.08 | 0.89 | 0.03 | 9.15 |
|  | High | State 3 | 15.81 | 31.11 | 0.04 | 0.00 | 0.94 | 16.09 |
| Tradable with low | Normal | State 1 | 10.58 | 3.31 | 0.96 | 0.19 | 0.07 | 22.56 |
|  | Low | State 2 | 5.48 | 3.31 | 0.03 | 0.81 | 0.00 | 5.32 |
|  | High | State 3 | 19.29 | 3.31 | 0.01 | 0.00 | 0.93 | 13.88 |

The expected durations of regimes are shown at the last column of Table 5. For overall inflation, low regime persists for almost twice times as long as normal and high regimes. To be precise, the expected durations of normal and high regimes are about 10 and 7 months while for low regime the expected duration is about 17 months. Inflation is likely to stay longer in low regimes for all inflation series, except that high (normal) regime is likely to be longer for tradable items having high (low) intermediate imports.

Having estimated the models, the next step is to classify the data based on the smoothed probabilities. Let's consider a 2 -state model. If the smoothed probability for state 2 at time $t$ is bigger than 0.5 , that is, $\mathbb{P}\left[\zeta_{t}=2 \mid \mathcal{F}_{\mathrm{T}}\right]>0.5$, then the series is considered in state 2 , at time $t$; otherwise the series is considered in state 1 . Similarly, for a 3 -state model, if the smoothed probability of a state is higher compared to those of other two states, then the series is considered in that state. Figures 2 to 8 show classification of inflation series being in their normal, low or high regimes, together with the smoothed probabilities. Investigation of the figures reveals that all inflation series are likely to preserve their low state except for tradable items with high intermediate imports, mostly oscillates between low and normal state.


Figure 2: Classification of overall inflation.
Notes: The top panel shows overall inflation. The second, third and fourth panels show the smoothed probabilities for normal (state 1), low state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure 3: Classification of tradable inflation.
Notes: The top panel shows tradable inflation. The second, third and fourth panels show the smoothed probabilities for low (state 1 ), normal state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.
$\qquad$

$\qquad$


Figure 4: Classification of non-tradable inflation.
Notes: The top panel shows non-tradable inflation. The second and third panels show the smoothed probabilities for high (state 1) and low (state 2) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked


Figure 5: Classification of inflation with high intermediate import.
Notes: The top panel shows inflation with high intermediate import. The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among he top panel is marked


Figure 6: Classification of inflation with low intermediate import.
Notes: The top panel shows inflation with low intermediate import. The second and third panels show the smoothed probabilities for high (state 1) and low (state 2) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is
marked.


Figure 7: Classification of tradable inflation with high intermediate import.
Notes: The top panel shows tradable inflation with high intermediate import. The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state s highest among all the other states, then it shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked

———state 1
$\qquad$

$\longrightarrow$ State 3


Figure 8: Classification of tradable inflation with low intermediate import.
Notes: The top panel shows tradable inflation with low intermediate import. The second, third and fourth panels show the smoothed probabilties for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.

## 4 Probability Score Analysis

### 4.1 Model

The performance of MS models is often tested by comparing regime probabilities with a reference series. For example, the performance of Markov switching model for the US business cycle is compared to the NBER chronology in Hamilton \& Perez-Quiros (1996). The probability score is defined as

$$
\begin{equation*}
P S=\frac{1}{T} \sum_{t=1}^{T}\left(P_{t}-D_{t}\right)^{2} \tag{3}
\end{equation*}
$$

where $P_{t}=\mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{\mathrm{T}}\right]$ denotes the model derived probability of a regime and $D_{t}$ is a dummy variable taking the value of 1 during corresponding phase obtained from a reference business cycle chronology. The closer these values are to zero, the more consistent are the model generated regime probabilities with the reference chronology.

In the following, we would like to investigate whether regimes of different inflation series can be related to regimes of a set of reference indicators extensively used in the literature in relating global factors to domestic inflation dynamics, namely exchange rates (US dollar, Euro and Basket), real effective exchange rate, foreign trade, global inflation and world trade variables. Also we include domestic industrial production in the set of reference indicators as it is a strong indicator for domestic economic condition. Accordingly, motivated by Equation 3 we introduce a probability score such that we compare the regime probabilities of each model (inflation series) with the regime probabilities of the reference series. Hence, we define the model versus reference probability score of state $j$, denoted by $P S_{j}^{M, R}$, as

$$
\begin{equation*}
P S_{j}^{M, R}=\frac{1}{T} \sum_{t=1}^{T}\left(P_{j, t}^{M}-P_{j, t}^{R}\right)^{2}, \quad j=1, \ldots, N \tag{4}
\end{equation*}
$$

where $P_{j, t}^{M}=\mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{\mathrm{T}}\right]$ denotes the model derived smoothed probability of regime $j$ and $P_{j, t}^{R}=\mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{\mathrm{T}}\right]$ denotes the reference derived smoothed probability of regime $j$. Similar to Equation 3, the closer these values are to zero, the more consistent are the model generated regime probabilities with reference generated regime probabilities.

Probability scores in Equation 4 are calculated using lags of -3 to 3 for each reference series. By doing this, we would like to investigate firstly if normal, low and high regimes of inflation series is associated with the corresponding regimes of reference series and secondly at which lag they are associated closely. When the probability score is at its minimum, the related regimes of inflation and reference series are more associated.

Before the probability score analysis, we computed the regime probabilities of the reference series as we did for inflation series. The estimation results are given in Table 6. ${ }^{17}$ In brief, results suggest that majority of the reference series is likely to stay longer at their low or normal states. However, Euro, Basket, ${ }^{18}$ import price index in TL, export volumes, fuel prices and world export prices are likely to stay longer at their high states. Duration for low and high states are almost equal for OECD inflation and terms of trade in US dollar. Variance exhibits a noticeable difference between the states for the reference series such as Basket, REER (CPI based), OECD inflation, import and export prices in TL, import and export volumes, terms of trade indicators, world export prices and volumes, and domestic industrial production.

[^9]Table 6: Proposed Markov regime-switching models for reference series.

|  | Regime | State | Mean | Variance | $p_{j 1}$ | $p_{j 2}$ | $p_{j 3}$ | Expected duration |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| US dollar | Normal | State 1 | 16.07 | 69.29 | 0.91 | 0.06 | 0.13 | 11.06 |
|  | Low | State 2 | -3.41 | 69.29 | 0.05 | 0.94 | 0.00 | 15.42 |
|  | High | State 3 | 38.62 | 69.29 | 0.04 | 0.00 | 0.87 | 7.73 |
| Euro | High | State 1 | 37.66 | 59.46 | 0.94 | 0.00 | 0.02 | 15.87 |
|  | Low | State 2 | -3.30 | 59.46 | 0.06 | 0.90 | 0.06 | 10.13 |
|  | Normal | State 3 | 16.04 | 59.46 | 0.00 | 0.10 | 0.92 | 12.69 |
| Basket | Normal | State 1 | 16.34 | 40.01 | 0.91 | 0.09 | 0.08 | 11.25 |
|  | Low | State 2 | -3.06 | 37.58 | 0.07 | 0.91 | 0.00 | 10.55 |
|  | High | State 3 | 40.03 | 205.64 | 0.02 | 0.00 | 0.92 | 13.06 |
| REER (CPI based) | Low | State 1 | -10.63 | 34.74 | 0.94 | 0.00 | 0.08 | 16.30 |
|  | High | State 2 | 9.68 | 30.08 | 0.06 | 0.86 | 0.06 | 7.39 |
|  | Normal | State 3 | -3.72 | 14.56 | 0.00 | 0.14 | 0.85 | 6.81 |
| REER (PPI based) | Low | State 1 | -7.83 | 18.47 | 0.93 | 0.00 | 0.13 | 14.01 |
|  | High | State 2 | 8.67 | 18.47 | 0.07 | 0.88 | 0.00 | 8.57 |
|  | Normal | State 3 | -1.41 | 18.47 | 0.00 | 0.12 | 0.87 | 7.68 |
| OECD inflation | Normal | State 1 | 1.99 | 0.10 | 0.92 | 0.07 | 0.07 | 12.82 |
|  | Low | State 2 | 0.80 | 0.23 | 0.04 | 0.93 | 0.00 | 13.71 |
|  | High | State 3 | 3.01 | 0.33 | 0.04 | 0.01 | 0.93 | 13.52 |
| OECD-Europe inflation | Low | State 1 | 1.07 | 0.13 | 0.95 | 0.03 | 0.03 | 20.85 |
|  | Normal | State 2 | 2.38 | 0.13 | 0.00 | 0.96 | 0.09 | 22.73 |
|  | High | State 3 | 3.48 | 0.13 | 0.05 | 0.02 | 0.88 | 8.64 |
| Import prices (US | High | State 1 | 11.11 | 51.77 | 0.97 | 0.02 |  | 34.73 |
| dollar) | Low | State 2 | -7.67 | 51.77 | 0.03 | 0.98 |  | 45.33 |
| Import prices (TL) | Normal | State 1 | 8.46 | 15.38 | 0.77 | 0.14 | 0.08 | 4.38 |
|  | Low | State 2 | -4.39 | 15.97 | 0.11 | 0.86 | 0.01 | 7.13 |
|  | High | State 3 | 27.94 | 154.91 | 0.12 | 0.00 | 0.91 | 10.86 |
| Import volumes | Normal | State 1 | 3.50 | 37.07 | 0.93 | 0.00 | 0.10 | 14.21 |
|  | Low | State 2 | -17.50 | 53.03 | 0.02 | 0.92 | 0.00 | 13.10 |
|  | High | State 3 | 16.81 | 43.49 | 0.05 | 0.08 | 0.90 | 10.12 |
| Export prices (US | High | State 1 | 14.59 | 40.40 | 0.94 | 0.02 |  | 15.93 |
| dollar) | Low | State 2 | -2.31 | 40.40 | 0.06 | 0.98 |  | 65.58 |
| Export prices (TL) | Normal | State 1 | 15.53 | 29.38 | 0.89 | 0.10 | 0.17 | 9.27 |
|  | Low | State 2 | -1.07 | 14.52 | 0.07 | 0.90 | 0.01 | 9.84 |
|  | High | State 3 | 35.30 | 176.49 | 0.04 | 0.00 | 0.82 | 5.65 |
| Export volumes | High | State 1 | 12.59 | 33.28 | 0.93 | 0.00 | 0.09 | 13.37 |
|  | Low | State 2 | -12.97 | 98.83 | 0.01 | 0.87 | 0.02 | 7.64 |
|  | Normal | State 3 | 2.28 | 28.91 | 0.07 | 0.13 | 0.89 | 9.50 |
| Export/Import prices (US dollar) | Low | State 1 | -3.77 | 4.37 | 0.94 | 0.22 | 0.00 | 18.09 |
|  | Normal | State 2 | -0.19 | 1.11 | 0.00 | 0.76 | 0.05 | 4.11 |
|  | High | State 3 | 3.86 | 7.98 | 0.06 | 0.03 | 0.95 | 18.74 |
| Export/Import prices (TL) | High | State 1 | 6.54 | 3.01 | 0.91 | 0.06 | 0.00 | 10.72 |
|  | Normal | State 2 | 1.81 | 2.31 | 0.09 | 0.84 | 0.06 | 6.37 |
|  | Low | State 3 | -3.67 | 4.08 | 0.00 | 0.10 | 0.94 | 15.94 |
| Export/Import volumes | Normal | State 1 | 9.25 | 55.01 | 0.86 | 0.02 | 0.09 | 7.05 |
|  | Low | State 2 | -5.35 | 72.61 | 0.14 | 0.98 | 0.06 | 45.63 |
|  | High | State 3 | 34.40 | 94.32 | 0.00 | 0.00 | 0.86 | 6.93 |
| Industrial production | Normal | State 1 | 5.68 | 8.21 | 0.94 | 0.07 | 0.11 | 16.41 |
|  | Low | State 2 | -7.71 | 57.41 | 0.03 | 0.91 | 0.02 | 10.68 |
|  | High | State 3 | 13.37 | 15.80 | 0.03 | 0.03 | 0.87 | 7.72 |
| Fuel prices | High | State 1 | 44.11 | 247.28 | 0.92 | 0.00 | 0.08 | 11.92 |
|  | Low | State 2 | -32.46 | 247.28 | 0.08 | 0.84 | 0.04 | 6.44 |
|  | Normal | State 3 | 1.95 | 247.28 | 0.00 | 0.16 | 0.89 | 8.91 |
| Commodity prices | High | State 1 | 34.68 | 92.41 | 0.94 | 0.00 | 0.03 | 17.11 |
|  | Low | State 2 | -12.29 | 92.41 | 0.06 | 0.95 | 0.03 | 20.01 |
|  | Normal | State 3 | 12.50 | 92.41 | 0.00 | 0.05 | 0.94 | 16.38 |
| World import prices | High | State 1 | 16.75 | 22.12 | 0.91 | 0.00 | 0.02 | 11.56 |
|  | Low | State 2 | -5.26 | 22.12 | 0.09 | 0.98 | 0.01 | 44.54 |
|  | Normal | State 3 | 7.06 | 22.12 | 0.00 | 0.02 | 0.96 | 28.20 |
| World import volumes | Normal | State 1 | 2.24 | 8.37 | 0.98 | 0.05 | 0.03 | 60.77 |
|  | Low | State 2 | -12.85 | 8.37 | 0.02 | 0.89 | 0.00 | 9.18 |
|  | High | State 3 | 9.31 | 8.37 | 0.00 | 0.06 | 0.97 | 30.28 |
| World export prices | Normal | State 1 | 6.54 | 6.06 | 0.89 | 0.03 | 0.02 | 9.34 |
|  | Low | State 2 | -5.36 | 32.83 | 0.09 | 0.96 | 0.02 | 24.86 |
|  | High | State 3 | 13.03 | 19.21 | 0.01 | 0.01 | 0.97 | 28.96 |
| World export volumes | Normal | State 1 | 2.37 | 3.92 | 0.98 | 0.00 | 0.03 | 57.69 |
|  | Low | State 2 | -11.33 | 41.64 | 0.02 | 0.95 | 0.00 | 19.74 |
|  | High | State 3 | 9.40 | 10.92 | 0.00 | 0.05 | 0.97 | 32.40 |

### 4.2 Results

The results of the probability score analysis for 23 reference series are displayed in Tables B. 3 to B. 25 in Appendix B. Minimum probability scores are shown in bold characters.

## Exchange Rates (US Dollar, Euro and Basket)

Changes in exchange rates can be passed-through to import prices to some extent depending on the market conditions. Consumer prices may react to the changes if imported goods take sufficient weight in the consumer basket. Accordingly, a stronger and direct relationship is expected between exchange rates and prices of tradable consumer goods and services. Prices of non-tradable goods may also be directly related with exchange rate changes as domestic consumer goods and services can be substitutes or complements to the imported ones and indirectly as some of the imported goods can be used to produce domestic consumption goods.

Table B. 3 shows the probability scores for the regimes of inflation groups against the regimes of the US dollar. Column 5 shows the regimes for inflation groups while regimes for US dollar are displayed at the top row. Starting with the overall inflation, when it is in normal regime probability score (0.28) is lowest if the US dollar is also in normal regime. When inflation is in low regime then lowest probability score (0.33) is reached if the US dollar is also in low regime. Similarly, lowest probability score (0.05) is attained when high regime of inflation is matched with high regime of US dollar. The probability score is at its minimum when high inflation regime is matched with high US dollar regime. The sub-period analysis also supports these results. ${ }^{19}$ This implies that high regime of inflation is much more related to high regime of US dollar. This conclusion is in line with Taylor (2000) propositions.

The aforementioned relationship can be observed between tradable goods inflation and US dollar, however the probability score is at the minimum when low regime of non-tradable goods is matched with normal regime of US dollar. This finding is consistent with the literature on the asymmetric response of tradable and non-tradable consumer price indices. Classification of goods and services in the consumer basket with respect to the intermediate imports ratio does not show a significant difference in the results, the minimum probability scores are attained when high regime of inflation is matched with high regime of US dollar.

The probability scores for the regimes of inflation groups against the regimes of Euro and Basket are given in Tables B. 4 and B.5, respectively. Conclusions driven from the analysis of both tables are almost mirror of each other and similar to the conclusions in Table B.3. Different from the results in Table B.3, here for non-tradable inflation the minimum probability score is attained when high inflation regime is matched with high Euro regime. High intermediate imports result in lower probability scores at low regimes of inflation and Euro. The fact that the results differ, especially on intermediate import inflation, may be related to the use of different currencies in the trade of consumer and intermediate goods.

## Real Effective Exchange Rate

The real effective exchange rate (REER) is the weighted average of a country's currency in relation to an index or a basket of other major currencies, procured by purifying relative price effects. The weights are determined by comparing the relative trade balance of a country's currency against each currency within the index. Therefore, it reflects the value of a domestic currency against other currencies adjusted for relative prices. REER is expressed in terms of domestic currency, therefore an increase in REER shows a real appreciation in domestic currency. The appreciation in domestic currency implies that with one unit of domestic currency it is possible to afford more imported goods and services. Cheaper imports, in turn, is expected to pressure domestic prices, leading to a negative relationship between REER and domestic inflation.

The probability score analysis is conducted using both CPI and PPI based REER. The results are presented in Tables B. 6 and B.7. In Table B.6, the expected relationship is observed for overall inflation, but for tradable and non-tradable inflation results are blurry. The sub-period analysis

[^10]also does not produce clear results, and in fact indicating that there is no stable relationship between inflation and REER.

Second part of Table B. 6 signify the importance of intermediate imports in determining the association between inflation and REER. The expected relationship is attained when inflation is computed separately for the goods and services classified based on their intermediate imports share. The results in Table B. 7 are even more mixed and in most cases do not appear to be in line with expectations. We attained expected relationships, once again when we compute inflation separately for tradable with high and low intermediate imports.

## OECD and OECD-Europe Inflation

OECD and OECD-Europe countries are the major trade partners of Turkey, therefore any inflationary movement can be transferred to domestic inflation through the exchange of goods and services. The linkage between OECD-Europe inflation and domestic inflation is expected to be stronger as the customs union between them enables the development of complex trade and production linkages.

Table B. 8 shows that the association between OECD inflation and domestic inflation varies depending on the type of inflation. The results are mixed. Table B.9, on the other hand, suggests a positive relationship between OECD-Europe inflation and domestic inflation for all cases, except for tradable inflation with low intermediate imports: minimum probability scores are attained when high inflation regimes are matched with high OECD-Europe inflation regime. The minimum probability scores are lower in Table B. 9 than in Table B. 8 suggesting a stronger relationship between OECD-Europe inflation and domestic inflation.

## Import Prices (in US Dollar and TL) and Import Volumes

Changes in import prices can affect domestic prices in two ways: directly if the imported consumption goods are included in the consumer basket and indirectly due to the usage of imported intermediates in the production of domestic consumption goods and services. Since a rise in import prices increases the cost of imported goods, it is expected to generate an upward pressure on domestic prices.

Two indices are used to represent import prices. The first one is in US dollar so that import price changes do not account for the changes in the value of TL against US dollar. The second one is in TL so that changes in the index reflect changes in the value of import price due to both price changes in US dollar and changes in the value of TL against US dollar. In the second case, while no change in the international price of a good is observed, its domestic price may change due to movements in the value of the domestic currency.

Table B. 10 reports the probability scores with reference to import prices in US dollar, while Table B. 11 includes the results with reference to import prices in TL. It is difficult to derive consistent conclusions from Table B.10. In most of the cases calculated probability scores are equal. This may simply imply that it is difficult to distinguish the relationship between import prices in US dollar and domestic prices or import prices in US dollar might show stable pattern, so that it is difficult to separate regimes shifts during the analysis period.

Conversion of import prices into domestic currency makes minor improvements in the results, but it is still difficult to derive conclusions consistent with the expectations (Table B.11). The results improve for the cases in which inflation is computed for tradable with high and low intermediate imports separately. Among the tradable goods and services having high (low) intermediate import ratio makes high (low) inflation regime associated with high (low) import prices in domestic currency. Lower probability scores in Table B. 11 compared to those in Table B. 10 signify the importance of exchange rate movements on domestic prices.

Table B. 12 documents a strong negative association between high inflation and import volumes. For almost all cases the probability scores are minimum when high inflation regimes are matched
with low import volumes. This is a plausible conclusion as increases in the volume of imports of goods and services increase domestically available goods and services for consumers. Increases in supply may lead to lower domestic prices. Our case suggest that during the analysis period, higher inflation regime is more associated with lower import volumes.

## Export Prices (in US Dollar and TL) and Export Volumes

There are different factors motivating countries to export, including selling excess production, getting benefit of price differences, etc. Domestic prices may be affected by an increase in exports, depending on how the increase in exports is achieved. If production capacity is expanded enough to meet domestic and external demand, then domestic prices may not be affected significantly by this increase. However, if domestic prices are adjusted to generate sufficient amount of goods and services for exports then an upward movement in domestic prices may be observed.

Similar to the preceding exercise, two export price indices are used in the analysis. Export prices in US dollar show the relative price of Turkish goods and services in international market. Export prices in TL reflect changes in the value of export prices due to both price change in US dollar and changes in the value of TL against US dollar.

In contrast to the analysis in Tables B. 10 and B.11, it is possible to make common inferences from the results in Tables B. 13 and B.14. The most important one is that both tables report minimum probability scores when high inflation is matched with high export prices (in US dollar and TL). Higher export prices are significantly associated with higher inflation rates. The minimum probability scores in Table B. 14 are lower than those in Table B. 13 once again indicating the importance of exchange rate effects on domestic inflation.

When the volume of exports increases, it must be met either by suppressing domestic demand (particularly, when production is constrained in the short run) or by increasing production. The impact on domestic prices depends on how the rise in export demand is fulfilled. Table B. 15 reports changing dynamics between domestic inflation and export volumes depending on the type of inflation. Overall, the minimum probability scores are attained when high inflation regimes are matched with low export volumes. However, low regime of the tradable inflation with low imported intermediate content is more related than high regime of it to low regime of export volumes.

## Terms of Trade and Export to Import Volume Ratio

Terms of trade, measured as a ratio of export to import prices, is used as one of the competitiveness indicators for a country. An increase in the ratio means that export price, in other words price paid by foreigners for goods and services of Turkish origin, increases (decreases) more (less) than the comparable price of imported goods and services, that is, the price that domestic consumers pay for similar goods and services of foreign origin. As a result, the increase implies weakening of relative competitiveness of a country. High terms of trade regime is expected to be associated more with high inflation regime, as low competitiveness may pose pressure on inflation.

The probability score analysis is conducted for both terms of trade in US dollar and TL (Tables B. 16 and B.17, respectively). The expected relationships in terms of domestic consumer perspective is much pronounced in Table B.17. Results in Table B. 17 suggest a stronger association between high regimes of overall, tradable, high and low intermediate imports inflation, tradable inflation with low intermediate imports and high regime of terms of trade, while high non-tradable inflation is more related with low terms of trade.

Exports, in a way, represent the amount of goods and services produced domestically and sold to other countries, while imports represent injections. Hence the net amount of them shows the net addition to the domestic supply of goods and services. An increase in the ratio of export to import volumes indicates a net decline in total supply, which may derive an inflationary pressure in the domestic market. Table B. 18 suggests that, in line with the expectations, the high regime of inflation is more likely to be associated with the high regime of export to import volume ratio. This outcome explains the relationships between all types of inflation and the export to import
volume ratio.
The minimum probability scores for export to import volume ratio in Table B. 18 are lower than those for price ratio in Table B.17. These results support the finding above: domestic prices are more related with regime switches in volumes rather than prices.

## Fuel Prices and Commodity Prices

Changes in fuel and commodity prices are expected to influence domestic prices because both of them can be used as an input in production. Fuel prices may induce an additional and direct impact as it has a weight in the consumer basket. Time to time these international prices may exhibit undesirable movements that concern the governments aiming to stabilize domestic prices. Accordingly, through various policy tools governments may control the pass-through of changes in fuel and commodity prices into domestic prices.

Tables B. 19 and B. 20 show the relationship between domestic inflation and fuel as well as commodity prices, respectively. The minimum probability scores are attained when high inflation regimes are matched with low fuel prices. This outcome is reached for all inflation types except for non-tradable inflation and tradable inflation with high intermediate imports. Meantime, the relationship between inflation and commodity prices are mostly positive. In other words, probability scores are at minimum when high inflation regimes are matched with high commodity prices. However, the result that, compared to the high regime, low regime of the tradable inflation with low imported intermediate content is more related to high regime of commodity prices is beyond expectations.

## World Import-Export Prices and World Import-Export Volumes

Another factor that may affect domestic prices is the changes in world or global prices and volumes. Changes in world prices and volumes can affect domestic and foreign prices of Turkish goods and services, since Turkey being a small open economy takes world prices as given while determining prices of local goods and services, tradable goods and services prices in particular. World price movements are expected to influence prices of Turkish goods and services in the same direction, while the changes in world volumes act in opposite directions.

In line with the expectations, Table B. 21 illustrates that the minimum probability scores are attained when high inflation regimes are matched with high world import price regimes. This finding is valid for all types of inflation except for non-tradable and tradable with low intermediate imports. The relationship between world import volume and domestic inflation are also in line with expectations, in other words high inflation regimes are more likely to be associated with low import volume (Table B.22). Only, for non-tradable and tradable with low intermediate import inflation the supported relationship differs.

Logically, world imports should be equal to world exports in terms of values, volumes and prices. However, the CBP World Trade Monitor shows an increasing discrepancy in global value and price levels since 2010: Import values and prices are above export values and prices, respectively, while import volume and export volume coincide relatively well. ${ }^{20}$ In Tables B. 23 and B. 24 we examine if this increasing discrepancy has a differentiating impact on the relationships reported in Tables B. 21 and B.22, respectively. But, our results report no significant impact difference, the results in Tables B. 23 and B. 24 are almost a mirror of Tables B. 21 and B.22, respectively.

## Industrial Production

Industrial production index is one of the significant indicators for domestic economic situation. Given that an increase in production eventually puts downward pressure on prices through an increase in supply, a negative association is expected between industrial production and domestic

[^11]inflation rate. The results reported in Table B. 25 support the expectations and suggest that high regimes of all types of inflation are more likely to be associated with low regime of industrial production. Tradable inflation is more related with industrial production but inclusion of high intermediate import tends to reduce the association.

## 5 Further Results and Conclusion

It is possible to derive further inferences by comparing the minimum probability scores and examine which inflation series are more related with which reference indicator. For this exercise we reorganize the results represented in Tables B. 3 to B. 25 in Appendix B. In order to focus on the most related relationships we report only the results that the minimum probability scores satisfy the condition of less than or equal to 0.40 in all regimes. For each inflation series, the summary of the results with the corresponding minimum probability scores are displayed in Tables C. 1 to C. 7 in Appendix C. These tables can be summarized further to obtain Table 7 which reports the most relevant indicator by inflation series in each regime.

Table 7: Probability scores for the most relevant indicator by inflation series in each regime.

| Inflation Group | High Regime of Inflation | Low Regime of Inflation | Normal Regime of Inflation |
| :---: | :---: | :---: | :---: |
| Overall | $\begin{gathered} \text { Euro (High) } \\ (0.00) \end{gathered}$ | Export/Import volumes (Low) $(0.26)$ | World export prices (Normal) (0.25) |
| Tradable | $\begin{gathered} \hline \text { Basket (High) } \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} \text { US dollar (Low) } \\ (0.33) \end{gathered}$ | $\begin{gathered} \text { US dollar (Normal)* } \\ (0.27) \\ \hline \end{gathered}$ |
| Nontradable | OECD inflation (High) <br> (0.21) | World import volumes (Normal) World export volumes (Normal) (0.22) |  |
| High int. import | $\begin{gathered} \text { Euro (High) } \\ \text { Basket (High) } \\ (0.01) \end{gathered}$ | US dollar (Low) Basket (Low) (0.23) | US dollar (Normal) (0.17) |
| Low int. import | $\begin{gathered} \text { Euro (High) } \\ (0.04) \\ \hline \end{gathered}$ | $\begin{aligned} & \text { Export/Import volumes (Low) } \\ & (0.30) \\ & \hline \end{aligned}$ |  |
| Tradable with high int. import | $\begin{aligned} & \text { Export prices (TL) (High) } \\ & (0.10) \end{aligned}$ | $\begin{aligned} & \text { REER (PPI based) (High) } \\ & (0.21) \\ & \hline \end{aligned}$ | REER (CPI based) (Normal) (0.21) |
| Tradable with low int. import | Euro (High) Basket (High) Export/Import volumes (High) $(0.08)$ | World import volumes (Low)** (0.17) | Industrial production (Normal) $(0.22)$ |

Notes: The corresponding probability scores and regimes of reference indicators are given in parenthesis.

* : The probability score is 0.27 for REER (CPI based) (low) and world export prices (normal), but they do not satisfy the property that minimum probability scores are less than or equal to 0.4 in all regimes.
** : The probability score is 0.13 for world import prices (high), but it does not satisfy the property that minimum probability scores are less than or equal to 0.4 in all regimes.

According to Table 7, the probability scores are at minimum when exchange rates are used as reference series except for non-tradable items and tradable items with high intermediate import content. For US dollar, Euro and Basket, probability scores are at minimum when high regimes of inflation for each group of goods and services are matched with high regimes of exchange rates. Hence, it can be concluded that during the analysis period high regimes of inflation are much more related with high regimes of exchange rates. This result is consistent with the literature finding positive relationship between inflation and exchange rate pass-through. The relationship between inflation and Euro is stronger than US dollar as the minimum probability score is lowest for Euro. However, the lag values at the Column 2 of Tables C. 1 to C. 7 indicate that inflation reacts more quickly to US dollar than Euro since the corresponding lag length for Euro is higher than US dollar for almost all types of inflation.

Comparison of the results in Table 7 shows that probability scores are lower for tradable inflation than non-tradable inflation in high regime of inflation. This suggests that tradable goods
and services inflation is more related to the changes in exchange rates. Having high imported intermediate content decreases the probability score values implying a stronger association between inflation of these items and exchange rates. In fact, an increase in TL value of US dollar can be reflected immediately to the price of items with high intermediate import content, while it may take one month for Euro change, on average (Table C.4). In case of items with low intermediate import content, on average, exchange rate changes may take 3 months to be passed-through to their prices (Table C.5). However, among the tradable goods and services the minimum probability scores are higher for those with high imported intermediate content, which suggest that increase in imported intermediate content is likely to smooth out the association between high inflation regime for tradable goods and high exchange rate regime. Therefore, high regimes of exchange rates are likely to affect non-tradable items with high intermediate imports more.

Additionally, one might ask the role that the energy items in the consumer basket plays in the relationship between exchange rates and inflation. We have computed new indices by excluding the items of energy in the consumer basket. ${ }^{21}$ The results of the corresponding probability score analysis are reported in Table C. 9 in Appendix C. In sum, exclusion of energy-related items does not affect our results: High regimes of all types of inflations are associated with high regimes of exchange rates. However, the corresponding probability score values become higher or lower depending on the regimes, that is the relationship becomes weaker or stronger (Tables C. 8 and C.9). Accordingly, the exchange rate relationship gets much stronger (weaker) for low (high) regime of tradable inflation for the excluded index. On the other hand, the exchange rate relationship gets much stronger for inflations of non-tradable, high intermediate import and tradable with high intermediate import for the excluded indices.

Moreover, Table 7 reveals that the association between inflation and REER (both CPI and PPI based) is mainly related with the tradable inflation with high imported intermediate content. In fact, the relationship between tradable inflation with high intermediate import content and CPI based REER is stronger than PPI based REER and the exchange rates (Table C.6). Berka et al. (2018) state that REER reflects the differences in the relative prices of non-traded and traded goods. Increase in differences may increase the relationship between REER and overall inflation. In our case, the results do not support a strong relationship between REER and inflation rates, suggesting that the relative prices of tradable to non-tradable goods may not show significant differences. Also, finding of an important relationship between REER and inflation for tradable goods with high import content is consistent with the argument that the relationship between REER and inflation will strengthen when there is no perfect substitute for imported goods.

In general, Tables C. 1 to C. 7 imply that probability scores are lower when volumes of exports and/or imports are used as a reference series, suggesting a stronger association between inflation and volumes rather than prices of exports and imports. Import volumes are likely to be more decisive on inflation as this matching has lower minimum probability scores than inflation-export volumes matching. High regime of tradable goods and services (high imported intermediate content) inflation is much more related with low regime of import volumes compared to non-tradable goods and services (low imported intermediate content) inflation. These findings are also valid when we consider industrial production. The minimum probability scores between fuel as well as commodity prices and inflation are below the condition ( 0.40 in all regimes) for overall inflation, non-tradable inflation and tradable inflation with high imported intermediate content.

Overall, the results support the view that the relationship between reference indicators and inflation changes depending on the regime of inflation. The exchange rates and export to import volume ratio stand out as the main reference indicators associated with the pace of inflation in Turkey, especially in high regime of inflation. In addition, the results are in line with the literature that the association between inflation and reference indicators may change depending on the trade structure of the items in the consumer basket. Actually, the aforementioned reference indicators better predict the acceleration in tradable inflation. It is shown in more detail that these cost indi-

[^12]cators are more closely related to the inflation of items with high intermediate imports, especially non-tradable items with high intermediate import content.

Our findings confirm the increasing impact of globalization on domestic inflation not only through the tradable sectors but also through the indirect impacts of imported intermediate goods. These results are of interest to policymakers as they indicate how complicated the conduct of monetary policy may turn out with globalization. Our findings reveal that the coordination of domestic monetary policy and trade policy is vital to improve the effectiveness of monetary policy. Enhancing competitiveness in both final and intermediate goods markets at different levels, from importers to domestic producers and consumers, can potentially contribute to the effectiveness of monetary policy in stabilizing domestic prices.

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## A Appendix A

## Brief Information on Markov Regime-Switching Models

In the following, we briefly describe the estimation of Markov regime-switching models. For illustrative purposes, we consider the following Markov regime-switching model

$$
\begin{equation*}
Y_{t}=\alpha_{\zeta_{t}}+\beta_{\zeta_{t}} Y_{t-1}+\sigma_{\zeta_{t}}^{2} \epsilon_{t}, \tag{5}
\end{equation*}
$$

where $\epsilon_{t} \sim \mathcal{N}(0,1)$. Here, $\zeta_{t}$ is an $N$-state Markov chain with transition matrix $\mathbf{P}=\left(p_{j i}\right)_{i, j=1, \ldots, N}$, where $p_{j i}=\mathbb{P}\left[\zeta_{t+1}=j \mid \zeta_{t}=i\right]$. For a detailed information on Markov chains, see Taylor \& Karlin (1998). Note that $p_{j i}$ gives the probability of switching from state $i$ at time $t\left(\zeta_{t}=i\right)$ to state $j$ at time $t+1\left(\zeta_{t+1}=j\right)$. Notice that parameters of the model, $\alpha_{\zeta_{t}}, \beta_{\zeta_{t}}$ and $\sigma_{\zeta_{t}}^{2}$, depend on the chain $\zeta_{t}$. That is,

$$
\begin{aligned}
\alpha_{\zeta_{t}} & =\alpha_{1} \zeta_{1 t}+\cdots+\alpha_{n} \zeta_{n t}+\cdots+\alpha_{N} \zeta_{N t} \\
\beta_{\zeta_{t}} & =\beta_{1} \zeta_{1 t}+\cdots+\beta_{n} \zeta_{n t}+\cdots+\beta_{N} \zeta_{N t} \\
\sigma_{\zeta_{t}}^{2} & =\sigma_{1}^{2} \zeta_{1 t}+\cdots+\sigma_{n}^{2} \zeta_{n t}+\cdots+\sigma_{N}^{2} \zeta_{N t}
\end{aligned}
$$

where, for $n=1, \ldots, N$,

$$
\zeta_{n t}= \begin{cases}1, & \text { if } \zeta_{t}=n \\ 0, & \text { otherwise }\end{cases}
$$

The problem is that we never know exactly when $\zeta_{t}=n$, as Markov chain $\zeta_{t}$ is not observed. Thus, estimation of Markov regime-switching models necessitates inferring the model parameters and states at the same time since the switching mechanism is unobservable. Markov regimeswitching models can be estimated by maximum likelihood method or Expectation-maximization (EM) algorithm, see Hamilton (1990) and Kim (1994). The EM algorithm is an alternative method for maximizing the likelihood function for models with missing observations or unobserved variables, see Nelson \& Kim (1999).

Now, we briefly explain some issues related to estimation of Markov regime-switching models. Let $\mathcal{F}_{t}$ refer to the information available at time $t=1, \ldots, \mathrm{~T}$. Then, the log-likelihood function is of the form

$$
\begin{equation*}
\ln (L)=\sum_{t=1}^{\mathrm{T}} \ln \left(f\left(y_{t} \mid \mathcal{F}_{t-1}\right)\right) \tag{6}
\end{equation*}
$$

where

$$
\begin{equation*}
f\left(y_{t} \mid \mathcal{F}_{t-1}\right)=\sum_{j=1}^{N} \mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{t-1}\right] f\left(y_{t} \mid \zeta_{t}=j, \mathcal{F}_{t-1}\right) \tag{7}
\end{equation*}
$$

Here, $\mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{t-1}\right]$ represents the predicted probability, see Equation 10. Clearly, to obtain the predicted probability, one needs $\mathbb{P}\left[\zeta_{t}=i \mid \mathcal{F}_{t}\right]$, which is called as filtered probability. Moreover, by using all sample information, one can obtain $\mathbb{P}\left[\zeta_{t}=i \mid \mathcal{F}_{\mathrm{T}}\right]$, which is called as smoothed probability.

In below, we explain filtering and smoothing steps briefly, for a detailed information, see Kim (1994). Filtering step is conducted as follows: For $t=1, \ldots, \mathrm{~T}$, iterate on

$$
\begin{align*}
& \mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{t}\right] \\
& =\frac{\mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{t-1}\right] f\left(y_{t} \mid \zeta_{t}=j, \mathcal{F}_{t-1}\right)}{\sum_{j=1}^{N} \mathbb{P}\left[\zeta_{t}=j \mid \mathcal{F}_{t-1}\right] f\left(y_{t} \mid \zeta_{t}=j, \mathcal{F}_{t-1}\right)}, \tag{8}
\end{align*}
$$

where

$$
\begin{align*}
& f\left(y_{t} \mid \zeta_{t}=j, \mathcal{F}_{t-1}\right) \\
& =\frac{1}{\sqrt{2 \pi} \sigma_{j}} \exp \left(-\frac{\left(y_{t}-\alpha_{j}-\beta_{j} y_{t-1}\right)^{2}}{2 \sigma_{j}^{2}}\right) \tag{9}
\end{align*}
$$

and

$$
\begin{equation*}
\mathbb{P}\left[\zeta_{t+1}=j \mid \mathcal{F}_{t}\right]=\sum_{i=1}^{N} p_{j i} \mathbb{P}\left[\zeta_{t}=i \mid \mathcal{F}_{t}\right] \tag{10}
\end{equation*}
$$

until $\mathbb{P}\left[\zeta_{\mathrm{T}}=j \mid \mathcal{F}_{\mathrm{T}}\right]$ is obtained. Afterwards, smoothing step is conducted as follows: For $t=$ $\mathrm{T}-1, \ldots, 1$, iterate on

$$
\begin{align*}
& \mathbb{P}\left[\zeta_{t}=i \mid \mathcal{F}_{\mathrm{T}}\right] \\
& =\sum_{j=1}^{N} \frac{\mathbb{P}\left[\zeta_{t+1}=j \mid \mathcal{F}_{\mathrm{T}}\right] \mathbb{P}\left[\zeta_{t}=i \mid \mathcal{F}_{t}\right] p_{j i}}{\mathbb{P}\left[\zeta_{t+1}=j \mid \mathcal{F}_{t}\right]} \tag{11}
\end{align*}
$$

Obviously, filtered probability $\mathbb{P}\left[\zeta_{t}=i \mid \mathcal{F}_{t}\right]$ represents the probability of $\zeta_{t}=i$ conditional on information up to time $t$, that is, $\mathcal{F}_{t}$. On the other hand, smoothed probabilitiy $\mathbb{P}\left[\zeta_{t}=i \mid \mathcal{F}_{\mathrm{T}}\right]$ represents the probability of $\zeta_{t}=i$ conditional on all the information $\mathcal{F}_{\mathrm{T}}$. That is, smoothed probabilities refer to inferences about $\zeta_{t}$ conditional on all the information $\mathcal{F}_{\mathrm{T}}$.

It is important to know that how long, on average, regime $j$ will last if we are currently in regime $j\left(\zeta_{t}=j\right)$. To this end, one can compute the expected duration of regime $j$

$$
\begin{equation*}
\mathbb{E}[\mathfrak{D}]=\frac{1}{1-p_{j j}}, \tag{12}
\end{equation*}
$$

where $\mathfrak{D}$ is the duration of state $j$, see Nelson \& Kim (1999). Remember that $p_{j j}$ gives the probability of staying in regime $j\left(\zeta_{t}=j\right)$ in the next period given that $\zeta_{t}=j$ in the current period.

## B Appendix B

Table B.1: Ratio of sectors with high/low intermediate import content (\%).

|  | Tradable | Nontradable | Ratio |
| :--- | :---: | :---: | :---: |
| High intermediate import | 54.84 | 8.77 | 35.12 |
| Low intermediate import | 45.16 | 91.23 | 64.88 |
| Total | 100.00 | 100.00 | 100.00 |

Table B.2: Ratio of tradable/nontradable sectors (\%).

|  | High intermediate <br> import | Low intermediate <br> import | Ratio |
| :--- | :---: | :---: | :---: |
| Tradable | 89.31 | 39.81 | 57.19 |
| Nontradable | 10.69 | 60.19 | 42.81 |
| Total | 100.00 | 100.00 | 100.00 |

## Probability Scores

Table B.3: Probability scores with reference to US dollar.

| Reference | Model | Lag | Model State | Model <br> Regime | Reference <br> State 1 <br> (Normal) | Reference State 2 (Low) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| US dollar | Overall | 1 | 1 | Normal | 0.28 | 0.48 | 0.38 |
|  |  |  | 2 | Low | 0.52 | 0.33 | 0.57 |
|  |  |  | 3 | High | 0.45 | 0.48 | 0.05 |
|  | Tradable | 2 | 1 | Low | 0.57 | 0.33 | 0.66 |
|  |  |  | 2 | Normal | 0.27 | 0.52 | 0.33 |
|  |  |  | 3 | High | 0.45 | 0.48 | 0.05 |
|  | Nontradable | -1 | 1 | High | 0.57 | 0.36 | 0.32 |
|  |  |  | 2 | Low | 0.31 | 0.55 | 0.61 |
|  | High int. import | 0 | 1 | Normal | 0.17 | 0.55 | 0.36 |
|  |  |  | 2 | Low | 0.6 | 0.23 | 0.55 |
|  |  |  | 3 | High | 0.45 | 0.48 | 0.05 |
|  | Low int. import | 3 | $1$ | High | 0.44 | $0.49$ | $0.1$ |
|  |  |  | $2$ | Low | 0.47 | 0.45 | $0.86$ |
|  | Tradable with high int. import | 0 | 1 | Normal | 0.36 | 0.41 | 0.43 |
|  |  |  | $2$ | Low | $0.57$ | $0.27$ | $0.38$ |
|  |  |  | 3 | High | 0.32 | 0.61 | 0.19 |
|  | Tradable with low int. import | 3 | 1 | Normal | 0.32 | 0.55 | 0.73 |
|  |  |  | $2$ | Low | 0.49 | 0.32 | 0.19 |
|  |  |  | 3 | High | 0.48 | 0.45 | 0.12 |

Table B.4: Probability scores with reference to Euro.

| Reference | Model | Lag | Model <br> State | Model <br> Regime | Reference <br> State 1 | Reference <br> State 2 <br> $($ Low $)$ | Reference <br> State 3 <br> (Normal) |
| :--- | :--- | :--- | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | (High) |  |  |

Table B.5: Probability scores with reference to Basket.

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (Normal) | Reference State 2 (Low) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Basket | Overall | 1 | 1 | Normal | 0.33 | 0.49 | 0.34 |
|  |  |  | 2 | Low | 0.49 | 0.32 | 0.64 |
|  |  |  | 3 | High | 0.53 | 0.46 | 0.01 |
|  | Tradable | 2 | 1 | Low | 0.5 | 0.35 | 0.73 |
|  |  |  | 2 | Normal | 0.36 | 0.5 | 0.29 |
|  |  |  | 3 | High | 0.54 | 0.47 | 0.00 |
|  | Nontradable | 3 | 1 | High | 0.59 | 0.39 | 0.3 |
|  |  |  | 2 | Low | 0.32 | 0.53 | 0.66 |
|  | High int. import | 1 | 1 | Normal | 0.24 | 0.54 | 0.32 |
|  |  |  | 2 | Low | 0.54 | 0.23 | 0.62 |
|  |  |  | 3 | High | 0.53 | 0.47 | 0.01 |
|  | Low int. import | 3 | 1 | High | 0.53 | 0.47 | 0.05 |
|  |  |  | 2 | Low | 0.4 | 0.47 | 0.93 |
|  | Tradable with high int. import | 1 | 1 | Normal | 0.38 | 0.42 | 0.43 |
|  |  |  | 2 | Low | 0.57 | 0.24 | 0.42 |
|  |  |  | 3 | High | 0.39 | 0.61 | 0.14 |
|  | Tradable | 3 | 1 | Normal | 0.3 | 0.55 | 0.77 |
|  | with low int. |  | 2 | Low | 0.52 | 0.32 | 0.17 |
|  | import |  | 3 | High | 0.56 | 0.44 | 0.08 |

Table B.6: Probability scores with reference to REER (CPI based).

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (Low) | Reference State 2 (High) | Reference <br> State 3 <br> (Normal) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| REER (CPI based) | Overall | 1 | 1 | Normal | 0.33 | 0.47 | 0.32 |
|  |  |  | 2 | Low | 0.62 | 0.34 | 0.46 |
|  |  |  | 3 | High | 0.24 | 0.38 | 0.34 |
|  | Tradable | -3 | 1 | Low | 0.68 | 0.48 | 0.41 |
|  |  |  | 2 | Normal | 0.27 | 0.41 | 0.42 |
|  |  |  | 3 | High | 0.29 | 0.34 | 0.34 |
|  | Nontradable | 2 | 1 | High | 0.48 | 0.45 | 0.31 |
|  |  |  | 2 | Low | 0.42 | 0.47 | 0.57 |
|  | High int. import | 2 | 1 | Normal | 0.24 | 0.5 | 0.33 |
|  |  |  | 2 | Low | 0.67 | 0.27 | 0.42 |
|  |  |  | 3 | High | 0.23 | 0.39 | 0.35 |
|  | Low int. import | 3 | 1 | High | 0.26 | $0.39$ | 0.35 |
|  |  |  | 2 | Low | 0.67 | 0.54 | 0.56 |
|  | Tradable with high int. import | 2 | 1 | Normal | 0.54 | 0.44 | 0.21 |
|  |  |  | 2 | Low | $0.52$ | $0.22$ | $0.45$ |
|  |  |  | 3 | High | 0.12 | 0.53 | 0.46 |
|  | Tradable with low int. import | 3 | 1 | Normal | 0.55 | 0.54 | 0.49 |
|  |  |  | 2 | Low | 0.36 | 0.33 | 0.29 |
|  |  |  | 3 | High | 0.3 | 0.36 | 0.37 |

Table B.7: Probability scores with reference to REER (PPI based).

| Reference | Model | Lag | Model <br> State | Model Regime | Reference <br> State 1 <br> (Low) | Reference State 2 (High) | Reference State 3 (Normal) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { REER (PPI } \\ & \text { based) } \end{aligned}$ | Overall | -3 | 1 | Normal | 0.28 | 0.43 | 0.43 |
|  |  |  | 2 | Low | 0.61 | 0.45 | 0.39 |
|  |  |  | 3 | High | 0.4 | 0.29 | 0.3 |
|  | Tradable | -2 | 1 | Low | 0.61 | 0.53 | 0.46 |
|  |  |  | 2 | Normal | 0.34 | 0.39 | 0.39 |
|  |  |  | 3 | High | 0.38 | 0.3 | 0.31 |
|  | Nontradable | 3 | 1 | High | 0.48 | 0.42 | 0.36 |
|  |  |  | 2 | Low | 0.44 | 0.51 | 0.55 |
|  | High int. import | 1 | 1 | Normal | 0.21 | 0.49 | 0.39 |
|  |  |  | 2 | Low | 0.7 | 0.31 | 0.38 |
|  |  |  | 3 | High | 0.34 | 0.35 | 0.31 |
|  | Low int. import | -3 | 1 | High | 0.42 | 0.34 | 0.28 |
|  |  |  | 2 | Low | 0.52 | 0.61 | 0.65 |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.5 | 0.47 | 0.26 |
|  |  |  | 2 | Low | 0.57 | 0.21 | 0.43 |
|  |  |  | 3 | High | 0.21 | 0.5 | 0.42 |
|  | Tradable with low int. import | -3 | 1 | Normal | 0.47 | 0.62 | 0.52 |
|  |  |  | 2 | Low | 0.4 | 0.28 | 0.32 |
|  |  |  | 3 | High | 0.45 | 0.3 | 0.31 |

Table B.8: Probability scores with reference to OECD inflation.
$\left.\begin{array}{lllccccc}\hline \text { Reference } & \text { Model } & \text { Lag } & \begin{array}{c}\text { Model } \\ \text { State }\end{array} & \begin{array}{c}\text { Model } \\ \text { Regime }\end{array} & \begin{array}{c}\text { Reference } \\ \text { State 1 }\end{array} & \begin{array}{c}\text { Reference } \\ \text { State 2 } \\ (\text { Normal })\end{array} & \begin{array}{c}\text { Reference } \\ \text { State }\end{array} \\ & & & & & \text { Low) } \\ \text { (High) }\end{array}\right]$

[^13]Table B.9: Probability scores with reference to OECD-Europe inflation.

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (Low) | Reference <br> State 2 <br> (Normal) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| OECD-Europe inflation | Overall | -1 | 1 | Normal | 0.49 | 0.36 | 0.34 |
|  |  |  | 2 | Low | 0.36 | 0.51 | 0.6 |
|  |  |  | 3 | High | 0.34 | 0.55 | 0.14 |
|  | Tradable | 3 | 1 | Low | 0.5 | 0.43 | 0.68 |
|  |  |  | 2 | Normal | 0.39 | 0.46 | 0.32 |
|  |  |  | 3 | High | 0.33 | 0.57 | 0.13 |
|  | Nontradable | 3 | 1 | High | 0.6 | 0.38 | 0.33 |
|  |  |  | 2 | Low | 0.36 | 0.55 | 0.62 |
|  | High int. import | 2 | 1 | Normal | 0.39 | 0.41 | 0.33 |
|  |  |  | 2 | Low | 0.42 | 0.41 | 0.59 |
|  |  |  | 3 | High | 0.33 | 0.57 | 0.13 |
|  | Low int. import | 2 | 1 | High | 0.37 | 0.52 | 0.17 |
|  |  |  | 2 | Low | 0.61 | 0.42 | 0.79 |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.32 | 0.45 | 0.48 |
|  |  |  | 2 | Low | 0.42 | 0.41 | 0.42 |
|  |  |  | 3 | High | 0.42 | 0.56 | 0.18 |
|  | Tradable | -3 | 1 | Normal | 0.52 | 0.46 | 0.66 |
|  | with low int. |  | 2 | Low | 0.35 | 0.49 | 0.2 |
|  | import |  | 3 | High | 0.35 | 0.49 | 0.26 |

Notes: OECD-Europe CPI index covers 26 OECD countries found in Europe, obtained from OECD.Stat (2020).

Table B.10: Probability scores with reference to import prices (US dollar).

| Reference | Model | Lag | Model State | Model Regime | Reference <br> State 1 <br> (High) | Reference State 2 (Low) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Import prices (US dollar) | Overall | 1 | 1 | Normal | 0.34 | 0.57 |
|  |  |  | 2 | Low | 0.55 | 0.36 |
|  |  |  | 3 | High | 0.53 | 0.44 |
|  | Tradable | -3 | 1 | Low | 0.45 | 0.5 |
|  |  |  | 2 | Normal | 0.44 | 0.51 |
|  |  |  | 3 | High | 0.56 | 0.41 |
|  | Nontradable | 3 | $1$ | High | $0.33$ | 0.61 |
|  |  |  | $2$ | Low | $0.61$ | 0.33 |
|  | High int. import | 3 | 1 | Normal | 0.39 | 0.48 |
|  |  |  | 2 | Low | 0.5 | 0.37 |
|  |  |  | 3 | High | 0.51 | 0.46 |
|  | Low int. import | -3 | $1$ | High | 0.59 | 0.36 |
|  |  |  | $2$ | Low | 0.36 | 0.59 |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.5 | 0.4 |
|  |  |  | 2 | Low | 0.5 | 0.41 |
|  |  |  | 3 | High | 0.42 | 0.54 |
|  | Tradable with low int. import | -3 | 1 | Normal | 0.43 | 0.51 |
|  |  |  | $2$ | Low | $0.43$ | $0.51$ |
|  |  |  | 3 | High | 0.58 | 0.39 |

Table B.11: Probability scores with reference to import prices (TL).

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (Normal) | $\begin{gathered} \hline \text { Reference } \\ \text { State } 2 \\ \text { (Low) } \\ \hline \end{gathered}$ | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Import prices (TL) | Overall | 0 | 1 | Normal | 0.38 | 0.5 | 0.26 |
|  |  |  | 2 | Low | 0.41 | 0.34 | 0.68 |
|  |  |  | 3 | High | 0.34 | 0.35 | 0.29 |
|  | Tradable | -2 | 1 | Low | 0.53 | 0.44 | 0.61 |
|  |  |  | 2 | Normal | 0.3 | 0.47 | 0.35 |
|  |  |  | 3 | High | 0.34 | 0.32 | 0.32 |
|  | Nontradable | 3 | 1 | High | 0.46 | 0.47 | 0.33 |
|  |  |  | 2 | Low | 0.43 | 0.47 | 0.59 |
|  | High int. import | 1 | 1 | Normal | 0.33 | 0.5 | 0.26 |
|  |  |  | 2 | Low | 0.42 | 0.29 | 0.67 |
|  |  |  | 3 | High | 0.35 | 0.36 | 0.27 |
|  | Low int. import | 2 |  | High | 0.34 | 0.36 | 0.32 |
|  |  |  | 2 | Low | 0.56 | 0.59 | 0.62 |
|  | Tradable with high int. import | 1 | 1 | Normal | 0.29 | 0.45 | 0.47 |
|  |  |  | 2 | Low | 0.39 | 0.23 | 0.58 |
|  |  |  | 3 | High | 0.44 | 0.51 | 0.18 |
|  | Tradable with low int. import | -3 | 1 | Normal | 0.51 | 0.59 | 0.5 |
|  |  |  | 2 | Low | 0.37 | 0.25 | 0.37 |
|  |  |  | 3 | High | 0.28 | 0.37 | 0.4 |

Table B.12: Probability scores with reference to import volumes.
$\left.\begin{array}{lllccccc}\hline \text { Reference } & \text { Model } & \text { Lag } & \begin{array}{c}\text { Model } \\ \text { State }\end{array} & \begin{array}{c}\text { Model } \\ \text { Regime }\end{array} & \begin{array}{c}\text { Reference } \\ \text { State 1 }\end{array} & \begin{array}{c}\text { Reference } \\ \text { State 2 } \\ \text { (Normal) }\end{array} & \begin{array}{c}\text { Reference } \\ \text { State 3 }\end{array} \\ & & & & & \text { Now } \\ \text { (High) }\end{array}\right]$

Table B.13: Probability scores with reference to export prices (US dollar).

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (High) | $\begin{gathered} \hline \text { Reference } \\ \text { State } 2 \\ \text { (Low) } \\ \hline \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Export prices (US dollar) | Overall | -3 | 1 | Normal | 0.37 | 0.53 |
|  |  |  | 2 | Low | 0.46 | 0.44 |
|  |  |  | 3 | High | 0.3 | 0.66 |
|  | Tradable | -2 | 1 | Low | 0.42 | 0.52 |
|  |  |  | 2 | Normal | 0.44 | 0.49 |
|  |  |  | 3 | High | 0.3 | 0.66 |
|  | Nontradable | 3 | 1 | High | 0.29 | 0.63 |
|  |  |  | 2 | Low | 0.63 | 0.29 |
|  | High int. import | 3 | 1 | Normal | 0.35 | 0.51 |
|  |  |  | 2 | Low | 0.44 | 0.43 |
|  |  |  | 3 | High | 0.31 | 0.64 |
|  | Low int. import | -3 |  | High | 0.33 | $0.62$ |
|  |  |  | 2 | Low | 0.62 | $0.33$ |
|  | Tradable with high int. import | -3 | 1 | Normal | 0.38 | 0.52 |
|  |  |  | 2 | Low | 0.32 | 0.58 |
|  |  |  | 3 | High | 0.43 | 0.53 |
|  | Tradable with low int. import | 0 | 1 | Normal | 0.58 | 0.34 |
|  |  |  | 2 | Low | 0.21 | 0.72 |
|  |  |  | 3 | High | 0.37 | 0.59 |

Table B.14: Probability scores with reference to export prices (TL).

| Reference | Model | Lag | Model State | Model Regime | Reference <br> State 1 <br> (Normal) | Reference State 2 (Low) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Export prices (TL) | Overall | 1 | 1 | Normal | 0.31 | 0.53 | 0.33 |
|  |  |  | 2 | Low | 0.52 | 0.3 | 0.64 |
|  |  |  | 3 | High | 0.54 | 0.43 | 0.04 |
|  | Tradable | 2 | 1 | Low | 0.44 | 0.41 | 0.75 |
|  |  |  | 2 | Normal | 0.43 | 0.47 | 0.26 |
|  |  |  | 3 | High | 0.55 | 0.43 | 0.03 |
|  | Nontradable | 1 | 1 | High | 0.44 | 0.52 | 0.32 |
|  |  |  | 2 | Low | 0.47 | 0.42 | 0.61 |
|  | High int. import | 1 | 1 | Normal | 0.27 | 0.56 | 0.28 |
|  |  |  | 2 | Low | 0.52 | 0.24 | 0.65 |
|  |  |  | 3 | High | 0.54 | 0.43 | 0.04 |
|  | Low int. import | 3 | 1 | High | 0.54 | 0.44 | 0.07 |
|  |  |  | 2 | Low | 0.4 | 0.52 | 0.89 |
|  | Tradable with high int. import | 1 | 1 | Normal | 0.32 | 0.47 | 0.45 |
|  |  |  | 2 | Low | 0.57 | 0.22 | $0.44$ |
|  |  |  | 3 | High | 0.47 | 0.57 | 0.1 |
|  | Tradable with low int. import | -1 | 1 | Normal | 0.34 | 0.57 | 0.72 |
|  |  |  | 2 | Low | 0.52 | 0.33 | 0.16 |
|  |  |  | 3 | High | 0.53 | 0.39 | 0.15 |

Table B.15: Probability scores with reference to export volumes.

| Reference | Model | Lag | Model <br> State | Model <br> Regime | Reference State 1 (High) | Reference State 2 (Low) | Reference <br> State 3 <br> (Normal) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Export volumes | Overall | -3 | 1 | Normal | 0.4 | 0.26 | 0.45 |
|  |  |  | 2 | Low | 0.46 | 0.59 | 0.37 |
|  |  |  | 3 | High | 0.45 | 0.14 | 0.37 |
|  | Tradable | 3 | 1 | Low | 0.37 | 0.63 | 0.55 |
|  |  |  | 2 | Normal | 0.55 | 0.27 | 0.29 |
|  |  |  | 3 | High | 0.44 | 0.14 | 0.38 |
|  | Nontradable | -2 | 1 | High | 0.3 | 0.34 | 0.59 |
|  |  |  | 2 | Low | 0.58 | 0.61 | 0.27 |
|  | High int. import | 3 | 1 | Normal | 0.42 | 0.31 | 0.33 |
|  |  |  | 2 | Low | 0.4 | 0.5 | 0.44 |
|  |  |  | 3 | High | 0.46 | 0.15 | 0.36 |
|  | Low int. import | -3 | 1 | High | 0.48 | 0.15 | 0.36 |
|  |  |  | 2 | Low | 0.41 | 0.81 | 0.52 |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.42 | 0.42 | 0.36 |
|  |  |  | 2 | Low | 0.43 | 0.3 | 0.45 |
|  |  |  | 3 | High | 0.47 | 0.27 | 0.36 |
|  | Tradable with low int. import | 3 | 1 | Normal | 0.44 | 0.67 | 0.46 |
|  |  |  | 2 | Low | 0.4 | 0.15 | 0.42 |
|  |  |  | 3 | High | 0.5 | 0.2 | 0.33 |

Table B.16: Probability scores with reference to export/import prices (US dollar).

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (Low) | Reference <br> State 2 <br> (Normal) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Export/Import prices (US dollar) | Overall | 1 | 1 | Normal | 0.32 | 0.33 | 0.5 |
|  |  |  | 2 | Low | 0.64 | 0.48 | 0.32 |
|  |  |  | 3 | High | 0.38 | 0.16 | 0.46 |
|  | Tradable | -1 | 1 | Low | 0.63 | 0.56 | 0.39 |
|  |  |  | 2 | Normal | 0.35 | 0.29 | 0.49 |
|  |  |  | 3 | High | 0.4 | 0.16 | 0.44 |
|  | Nontradable | 3 | 1 | High | 0.35 | 0.38 | 0.53 |
|  |  |  | 2 | Low | 0.58 | 0.53 | 0.38 |
|  | High int. import | 2 | 1 | Normal | 0.3 | 0.28 | 0.51 |
|  |  |  | 2 | Low | 0.63 | 0.49 | 0.26 |
|  |  |  | 3 | High | 0.37 | 0.16 | 0.46 |
|  | Low int. import | -3 | 1 | High | 0.48 | 0.21 | 0.35 |
|  |  |  | 2 | Low | 0.47 | 0.72 | 0.58 |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.46 | 0.31 | 0.45 |
|  |  |  | 2 | Low | 0.59 | 0.36 | 0.26 |
|  |  |  | 3 | High | 0.28 | 0.29 | 0.56 |
|  | Tradable | -3 | 1 | Normal | 0.5 | 0.61 | 0.5 |
|  | with low int. |  | 2 | Low | 0.42 | 0.16 | 0.42 |
|  | import |  | 3 | High | 0.45 | 0.23 | 0.38 |

Table B.17: Probability scores with reference to export/import prices (TL).

| Reference | Model | Lag | Model <br> State | Model Regime | Reference <br> State 1 <br> (High) | Reference <br> State 2 (Normal) | Reference <br> State 3 <br> (Low) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Export/Import <br> prices (TL) | Overall | 3 | 1 | Normal | 0.37 | 0.47 | 0.34 |
|  |  |  | 2 | Low | 0.48 | 0.36 | 0.63 |
|  |  |  | 3 | High | 0.26 | 0.36 | 0.39 |
|  | Tradable | -3 | 1 | Low | 0.58 | 0.43 | 0.6 |
|  |  |  | 2 | Normal | 0.32 | 0.45 | 0.37 |
|  |  |  | 3 | High | 0.25 | 0.33 | 0.43 |
|  | Nontradable | 1 | 1 | High | 0.46 | 0.48 | 0.35 |
|  |  |  | 2 | Low | 0.48 | 0.43 | 0.59 |
|  | High int. import | 2 | 1 | Normal | 0.36 | 0.44 | 0.32 |
|  |  |  | 2 | Low | 0.44 | 0.35 | 0.61 |
|  |  |  | 3 | High | 0.27 | 0.35 | 0.39 |
|  | Low int. import | -3 | 1 | High | 0.21 | 0.35 | 0.48 |
|  |  |  | 2 | Low | 0.75 | 0.57 | 0.47 |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.33 | 0.44 | 0.46 |
|  |  |  | 2 | Low | 0.38 | 0.27 | 0.58 |
|  |  |  | 3 | High | 0.38 | 0.46 | 0.31 |
|  | Tradable with low int. import | -3 | 1 | Normal | 0.64 | 0.48 | 0.51 |
|  |  |  | 2 | Low | 0.28 | 0.32 | 0.42 |
|  |  |  | 3 | High | 0.23 | 0.39 | 0.46 |

Table B.18: Probability scores with reference to export/import volumes.

| Reference | Model | Lag | Model State | Model <br> Regime | Reference <br> State 1 <br> (Normal) | Reference State 2 (Low) | Reference <br> State 3 <br> (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Export/Import volumes | Overall | 0 | 1 | Normal | 0.26 | 0.52 | 0.35 |
|  |  |  | 2 | Low | 0.52 | 0.26 | 0.63 |
|  |  |  | 3 | High | 0.31 | 0.64 | 0.02 |
|  | Tradable | 0 | 1 | Low | 0.47 | 0.35 | 0.73 |
|  |  |  | 2 | Normal | 0.35 | 0.47 | 0.28 |
|  |  |  | 3 | High | 0.31 | 0.64 | 0.01 |
|  | Nontradable | -1 | 1 | High | 0.36 | 0.56 | 0.32 |
|  |  |  | 2 | Low | 0.51 | 0.31 | 0.65 |
|  | High int. import | 0 | 1 | Normal | $\mathbf{0 . 2 4}$ | 0.5 | 0.32 |
|  |  |  | 2 | Low | 0.5 | 0.24 | 0.61 |
|  |  |  | 3 | High | 0.31 | 0.64 | 0.02 |
|  | Low int. import | 3 | 1 | High | 0.36 | 0.59 | 0.06 |
|  |  |  | 2 | Low | 0.53 | 0.3 | 0.93 |
|  | Tradable with high int. import | -1 | 1 | Normal | 0.31 | 0.46 | 0.42 |
|  |  |  | 2 | Low | 0.45 | 0.34 | 0.41 |
|  |  |  | 3 | High | 0.33 | 0.61 | 0.15 |
|  | Tradable with low int. import | 3 | 1 | Normal | 0.47 | 0.33 | 0.77 |
|  |  |  | 2 | Low | 0.27 | 0.54 | 0.16 |
|  |  |  | 3 | High | 0.38 | 0.57 | 0.08 |

Table B.19: Probability scores with reference to fuel prices.

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (High) | Reference State 2 (Low) | Reference State 3 (Normal) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Fuel prices | Overall | -3 | 1 | Normal | 0.47 | 0.33 | 0.32 |
|  |  |  | 2 | Low | 0.37 | 0.53 | 0.54 |
|  |  |  | 3 | High | 0.4 | 0.24 | 0.35 |
|  | Tradable | -3 | 1 | Low | 0.44 | 0.56 | 0.58 |
|  |  |  | 2 | Normal | 0.45 | 0.34 | 0.32 |
|  |  |  | 3 | High | 0.4 | 0.24 | 0.35 |
|  | Nontradable | 3 | 1 | High | 0.25 | 0.45 | 0.55 |
|  |  |  | 2 | Low | 0.68 | 0.46 | 0.34 |
|  | High int. import | -3 | 1 | Normal | 0.42 | 0.36 | 0.3 |
|  |  |  | 2 | Low | 0.41 | 0.46 | 0.52 |
|  |  |  | 3 | High | 0.39 | 0.25 | 0.36 |
|  | Low int. import | -3 | $1$ | High | $0.43$ | $0.21$ | 0.38 |
|  |  |  | 2 | Low | 0.52 | 0.71 | 0.53 |
|  | Tradable with high int. import | -3 | 1 | Normal | 0.47 | 0.36 | 0.38 |
|  |  |  | 2 | Low | 0.33 | 0.38 | 0.5 |
|  |  |  | 3 | High | 0.44 | 0.35 | 0.32 |
|  | Tradable | -1 | 1 | Normal | 0.58 | 0.59 | 0.43 |
|  | with low int. |  | 2 | Low | 0.27 | 0.3 | 0.42 |
|  | import |  | 3 | High | 0.42 | 0.24 | 0.39 |

Table B.20: Probability scores with reference to commodity prices.

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (High) | Reference State 2 (Low) | Reference <br> State 3 <br> (Normal) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Commodity prices | Overall | 3 | 1 | Normal | 0.31 | 0.56 | 0.31 |
|  |  |  | 2 | Low | 0.55 | 0.36 | 0.56 |
|  |  |  | 3 | High | 0.24 | 0.41 | 0.37 |
|  | Tradable | 3 | 1 | Low | 0.58 | 0.46 | 0.56 |
|  |  |  | 2 | Normal | 0.31 | 0.51 | 0.34 |
|  |  |  | 3 | High | 0.24 | 0.41 | 0.37 |
|  | Nontradable | 3 | 1 | High | 0.44 | 0.59 | 0.26 |
|  |  |  | 2 | Low | 0.52 | 0.34 | 0.66 |
|  | High int. import | 3 | 1 | Normal | 0.31 | 0.49 | 0.33 |
|  |  |  | 2 | Low | 0.51 | 0.39 | 0.51 |
|  |  |  | 3 | High | 0.24 | 0.42 | 0.36 |
|  | Low int. import | 0 | 1 | High | 0.29 | 0.36 | 0.41 |
|  |  |  | 2 | Low | 0.68 | 0.58 | 0.53 |
|  | Tradable with high int. import | 1 | 1 | Normal | 0.29 | 0.46 | 0.49 |
|  |  |  | 2 | Low | 0.44 | 0.4 | 0.4 |
|  |  |  | 3 | High | 0.35 | 0.46 | 0.34 |
|  | Tradable with low int. import | 0 | 1 | Normal | 0.69 | 0.5 | 0.45 |
|  |  |  | 2 | Low | 0.18 | 0.47 | 0.37 |
|  |  |  | 3 | High | 0.24 | 0.38 | 0.45 |

Table B.21: Probability scores with reference to world import prices.

| Reference | Model | Lag | Model <br> State | Model <br> Regime | Reference <br> State 1 | Reference <br> State 2 <br> $($ Low $)$ | Reference <br> State 3 <br> (Normal) |
| :--- | :--- | :--- | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | (High) |  |  |

Table B.22: Probability scores with reference to world import volumes.

| Reference | Model | Lag | Model State | Model <br> Regime | Reference <br> State 1 <br> (Normal) | Reference State 2 (Low) | Reference <br> State 3 <br> (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| World import volumes | Overall | -3 | 1 | Normal | 0.55 | 0.27 | 0.37 |
|  |  |  | 2 | Low | 0.43 | 0.59 | 0.48 |
|  |  |  | 3 | High | 0.53 | 0.16 | 0.35 |
|  | Tradable | 3 | 1 | Low | 0.57 | 0.64 | 0.41 |
|  |  |  | 2 | Normal | 0.46 | 0.26 | 0.47 |
|  |  |  | 3 | High | 0.53 | 0.15 | 0.36 |
|  | Nontradable | -3 | 1 | High | 0.72 | 0.34 | 0.25 |
|  |  |  | 2 | Low | 0.22 | 0.62 | 0.7 |
|  | High int. import | 0 | 1 | Normal | 0.43 | 0.31 | 0.41 |
|  |  |  | 2 | Low | 0.52 | 0.52 | 0.4 |
|  |  |  | 3 | High | 0.52 | 0.16 | 0.36 |
|  | Low int. import | -3 | $1$ | High | $0.54$ | $0.16$ | $0.38$ |
|  |  |  | 2 | Low | 0.42 | 0.82 | $0.59$ |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.54 | 0.42 | 0.31 |
|  |  |  | 2 | Low | 0.57 | 0.31 | 0.38 |
|  |  |  | 3 | High | 0.4 | 0.27 | 0.51 |
|  | Tradable with low int. import | -3 | 1 | Normal | 0.38 | 0.71 | 0.58 |
|  |  |  | 2 | Low | 0.59 | 0.17 | 0.29 |
|  |  |  | 3 | High | 0.58 | 0.17 | 0.36 |

Table B.23: Probability scores with reference to world export prices.

| Reference | Model | Lag | Model State | Model Regime | Reference State 1 (Normal) | Reference State 2 (Low) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| World export prices | Overall | 1 | 1 | Normal | 0.25 | 0.57 | 0.36 |
|  |  |  | 2 | Low | 0.63 | 0.37 | 0.48 |
|  |  |  | 3 | High | 0.36 | 0.44 | 0.23 |
|  | Tradable | -1 | 1 | Low | 0.63 | 0.48 | 0.51 |
|  |  |  | 2 | Normal | 0.27 | 0.51 | 0.37 |
|  |  |  | 3 | High | 0.38 | 0.42 | 0.22 |
|  | Nontradable | 3 | 1 | High | 0.38 | 0.6 | 0.31 |
|  |  |  | 2 | Low | 0.55 | 0.35 | 0.63 |
|  | High int. import | -2 | 1 | Normal | 0.25 | 0.5 | 0.38 |
|  |  |  | 2 | Low | 0.58 | 0.42 | 0.43 |
|  |  |  | 3 | High | 0.38 | 0.42 | 0.22 |
|  | Low int. import | -3 | 1 | High | 0.46 | 0.36 | 0.24 |
|  |  |  | 2 | Low | 0.48 | 0.61 | 0.72 |
|  | Tradable with high int. import | -2 | 1 | Normal | 0.38 | 0.43 | 0.44 |
|  |  |  | 2 | Low | 0.54 | 0.44 | 0.27 |
|  |  |  | 3 | High | 0.31 | 0.5 | 0.35 |
|  | Tradable | -2 | 1 | Normal | 0.5 | 0.52 | 0.63 |
|  | with low int. |  | 2 | Low | 0.35 | 0.5 | 0.18 |
|  | import |  | 3 | High | 0.42 | 0.38 | 0.29 |

Table B.24: Probability scores with reference to world export volumes.

| Reference | Model | Lag | Model State | Model Regime | Reference <br> State 1 <br> (Normal) | Reference State 2 (Low) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| World export volumes | Overall | -3 | 1 | Normal | 0.55 | 0.25 | 0.38 |
|  |  |  | 2 | Low | 0.43 | 0.6 | 0.46 |
|  |  |  | 3 | High | 0.5 | 0.17 | 0.37 |
|  | Tradable | 3 | 1 | Low | 0.58 | 0.64 | 0.39 |
|  |  |  | 2 | Normal | 0.44 | 0.25 | 0.49 |
|  |  |  | 3 | High | 0.5 | 0.16 | 0.38 |
|  | Nontradable | -3 | 1 | High | 0.72 | 0.32 | 0.26 |
|  |  |  | 2 | Low | 0.22 | 0.63 | 0.69 |
|  | High int. import | 2 | 1 | Normal | 0.42 | 0.31 | 0.42 |
|  |  |  | 2 | Low | 0.53 | 0.51 | $0.39$ |
|  |  |  | 3 | High | 0.49 | 0.16 | 0.39 |
|  | Low int. import | -3 | 1 | High | 0.53 | 0.15 | 0.4 |
|  |  |  | 2 | Low | 0.43 | 0.83 | 0.57 |
|  | Tradable with high int. import | 3 | 1 | Normal | 0.53 | 0.42 | 0.32 |
|  |  |  | 2 | Low | 0.57 | 0.31 | 0.38 |
|  |  |  | 3 | High | 0.37 | 0.28 | 0.53 |
|  | Tradable | -3 | 1 | Normal | 0.38 | 0.71 | 0.57 |
|  | with low int. |  | 2 | Low | 0.56 | 0.18 | 0.3 |
|  | import |  | 3 | High | 0.56 | 0.17 | 0.37 |

Table B.25: Probability scores with reference to industrial production.

| Reference | Model | Lag | Model <br> State | Model <br> Regime | Reference <br> State 1 <br> (Normal) | Reference State 2 (Low) | Reference State 3 (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Industrial production | Overall | -3 | 1 | Normal | 0.47 | 0.31 | 0.37 |
|  |  |  | 2 | Low | 0.36 | 0.65 | 0.45 |
|  |  |  | 3 | High | 0.59 | 0.1 | 0.31 |
|  | Tradable | 0 | 1 | Low | 0.36 | 0.67 | 0.56 |
|  |  |  | 2 | Normal | 0.5 | 0.34 | 0.3 |
|  |  |  | 3 | High | 0.59 | 0.09 | 0.32 |
|  | Nontradable | -3 | 1 | High | 0.6 | 0.27 | 0.4 |
|  |  |  | 2 | Low | 0.3 | 0.68 | 0.52 |
|  | High int. import | -1 | 1 | Normal | 0.43 | 0.38 | 0.3 |
|  |  |  | 2 | Low | 0.36 | 0.55 | 0.49 |
|  |  |  | 3 | High | 0.59 | 0.1 | 0.32 |
|  | Low int. import | -1 | $1$ | High | 0.58 | $0.11$ | $0.35$ |
|  |  |  | 2 | Low | 0.34 | 0.85 | 0.59 |
|  | Tradable with high int. import | -3 | 1 | Normal | 0.43 | 0.45 | 0.35 |
|  |  |  | 2 | Low | 0.43 | 0.38 | 0.42 |
|  |  |  | 3 | High | 0.55 | 0.23 | 0.36 |
|  | Tradable with low int. import | 0 | 1 | Normal | 0.22 | 0.74 | 0.67 |
|  |  |  | 2 | Low | 0.61 | 0.22 | 0.18 |
|  |  |  | 3 | High | 0.61 | 0.13 | 0.32 |

## C Appendix C

## Summary of Probability Scores

Reference variables satisfying the property that all regimes with minimum probability scores less than or equal to 0.4 are reported below.

Table C.1: Summary of probability scores for overall inflation.

| Model | Lag | Reference | Reference Regime | Model Regime (Normal) | Model <br> Regime <br> (Low) | Model <br> Regime <br> (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Overall | 1 | US dollar | Normal Low High | 0.28 | 0.33 | 0.05 |
|  | 2 | Euro | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \\ \hline \end{gathered}$ | 0.31 | 0.3 | 0.00 |
|  | 1 | Basket | Normal Low High | 0.33 | 0.32 | 0.01 |
|  | 1 | $\begin{aligned} & \hline \text { REER } \\ & \text { (CPI } \\ & \text { based) } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.32 | 0.34 | 0.24 |
|  | -3 | $\begin{aligned} & \hline \text { REER } \\ & \text { (PPI } \\ & \text { based) } \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.28 | 0.39 | 0.29 |
|  | -1 | OECDEurope inflation | $\begin{aligned} & \hline \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.36 | 0.36 | 0.14 |
|  | 1 | Import prices (US) | Low High | 0.34 | 0.36 |  |
|  | 0 | Import prices (TL) | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.26 | 0.34 | 0.34 |
|  | -3 | Import volumes | Normal Low High | 0.36 | 0.33 | 0.1 |
|  | 1 | Export prices (TL) | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \end{aligned}$ | 0.31 | 0.3 | 0.04 |
|  | -3 | Export volumes | Normal Low High | 0.4 | 0.37 | 0.14 |
|  | 1 | Exp/Imp prices (US) | $\begin{aligned} & \hline \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.32 | 0.32 | 0.16 |
|  | 3 | Exp/Imp prices (TL) | Normal Low High | 0.34 | 0.36 | 0.26 |
|  | 0 | Exp/Imp volumes | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.26 | 0.26 | 0.02 |
|  | -3 | Fuel prices | Normal Low High | 0.32 | 0.37 | 0.24 |
|  | 3 | Commodity prices | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.31 | 0.36 | 0.24 |
|  | 2 | World import prices | Normal Low High | 0.35 | 0.35 | 0.18 |
|  | 1 | World export prices | $\begin{aligned} & \hline \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.25 | 0.37 | 0.23 |
|  | -3 | Industrial production | $\begin{aligned} & \hline \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.37 | 0.36 | 0.1 |

Table C.2: Summary of probability scores for tradable inflation.

| Model | Lag | Reference | Reference <br> Regime | Model <br> Regime <br> (Normal) | Model <br> Regime <br> (Low) | Model <br> Regime <br> (High) |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | 2 | US | Normal <br> Low <br> High | $\mathbf{0 . 2 7}$ |  | $\mathbf{0 . 3 3}$ |

Table C.3: Summary of probability scores for nontradable inflation.

| Model | Lag | Reference | Reference Regime | Model Regime (Low) | Model Regime <br> (High) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Nontradable | -1 | US <br> dollar | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \end{gathered}$ | 0.31 | 0.32 |
|  | 3 | Euro | Normal <br> Low <br> High | 0.33 | 0.29 |
|  | 3 | Basket | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \end{aligned}$ | 0.32 | 0.3 |
|  | 3 | OECD <br> inflation | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \end{gathered}$ | 0.36 | 0.21 |
|  | 3 | OECDEurope inflation | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \end{gathered}$ | 0.36 | 0.33 |
|  | 3 | Import prices (US) | Low <br> High | 0.33 | 0.33 |
|  | -3 | Import volumes | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \end{aligned}$ | 0.31 | 0.31 |
|  | 3 | Export prices (US) | Low <br> High | 0.29 | 0.29 |
|  | -2 | Export volumes | Normal Low High | 0.27 | 0.3 |
|  | 3 | Exp/Imp prices (US) | Normal Low High | 0.38 | 0.35 |
|  | -1 | Exp/Imp volumes | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \end{aligned}$ | 0.31 | 0.32 |
|  | 3 | Fuel prices | Normal Low High | 0.34 | 0.25 |
|  | 3 | Commodity prices | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \end{aligned}$ | 0.34 | 0.26 |
|  | 3 | World import <br> prices | Normal Low High | 0.34 | 0.32 |
|  | -3 | World import volumes | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \end{gathered}$ | 0.22 | 0.25 |
|  | 3 | World export prices | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \end{gathered}$ | 0.35 | 0.31 |
|  | -3 | World export volumes | Normal Low High | 0.22 | 0.26 |
|  | -3 | Industrial production | Normal Low High | 0.3 | 0.27 |

Table C.4: Summary of probability scores for inflation with high intermediate import.
$\left.\begin{array}{lclllll}\hline \text { Model } & \text { Lag } & \text { Reference } & \begin{array}{c}\text { Reference } \\ \text { Regime }\end{array} & \begin{array}{c}\text { Model } \\ \text { Regime } \\ \text { (Normal) }\end{array} & \begin{array}{c}\text { Model } \\ \text { Regime } \\ \text { (Low) }\end{array} & \begin{array}{c}\text { Model } \\ \text { Regime } \\ \text { (High) }\end{array} \\ \hline & 0 & \begin{array}{l}\text { US } \\ \text { dollar }\end{array} & \begin{array}{c}\text { Normal } \\ \text { Low } \\ \text { High }\end{array} & \mathbf{0 . 1 7} & & \mathbf{0 . 2 3}\end{array}\right]$

Table C.5: Summary of probability scores inflation with low intermediate import.

| Model | Lag | Reference | Reference <br> Regime | Model <br> Regime <br> (Low) | Model <br> Regime <br> (High) |
| :--- | :---: | :--- | :--- | :---: | :---: |
|  | 3 | Euro | Normal <br> Low <br> High | 0.35 |  |
|  | 3 | Basket | Normal <br> Low <br> High | 0.4 | 0.04 |
| Low <br> intermediate <br> import | -3 | Import <br> prices <br> (US) | Low <br> High | 0.36 | 0.36 |
|  | -3 | Import <br> volumes | Normal <br> Low <br> High | 0.36 | 0.11 |
|  | 3 | Export <br> prices <br> (US) | Low <br> Export <br> prices <br> (TL) | Normal <br> Low <br> High | 0.33 |

Table C.6: Summary of probability scores tradable inflation with high intermediate import.

| Model | Lag | Reference | Reference Regime | Model <br> Regime <br> (Normal) | Model <br> Regime <br> (Low) | Model <br> Regime <br> (High) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Tradable with high intermediate import | 0 | US <br> dollar | Normal Low High | 0.36 | 0.27 | 0.19 |
|  | 1 | Euro | Normal Low High | 0.34 | 0.22 | 0.13 |
|  | 1 | Basket | Normal Low High | 0.38 | 0.24 | 0.14 |
|  | 2 | $\begin{aligned} & \hline \text { REER } \\ & \text { (CPI } \\ & \text { based) } \end{aligned}$ | Normal Low High | 0.21 | 0.22 | 0.12 |
|  | 3 | $\begin{aligned} & \hline \text { REER } \\ & \text { (PPI } \\ & \text { based) } \end{aligned}$ | $\begin{aligned} & \text { Normal } \\ & \text { Low } \\ & \text { High } \end{aligned}$ | 0.26 | 0.21 | 0.21 |
|  | 1 | Import prices (TL) | $\begin{aligned} & \hline \text { Normal } \\ & \text { Low } \\ & \text { High } \\ & \hline \end{aligned}$ | 0.29 | 0.23 | 0.18 |
|  | -1 | Import volumes | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \end{gathered}$ | 0.28 | 0.32 | 0.2 |
|  | 1 | Export prices (TL) | Normal Low High | 0.32 | 0.22 | 0.1 |
|  | 3 | $\begin{aligned} & \text { Exp/Imp } \\ & \text { prices } \\ & \text { (US) } \end{aligned}$ | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \\ \hline \end{gathered}$ | 0.31 | 0.26 | 0.28 |
|  | 3 | Exp/Imp prices <br> (TL) | Normal Low High | 0.33 | 0.27 | 0.31 |
|  | -1 | Exp/Imp volumes | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \\ \hline \end{gathered}$ | 0.31 | 0.34 | 0.15 |
|  | -3 | Fuel prices | $\begin{gathered} \text { Normal } \\ \text { Low } \\ \text { High } \\ \hline \end{gathered}$ | 0.36 | 0.33 | 0.32 |
|  | 1 | Commodity prices | Normal Low High | 0.29 | 0.4 | 0.34 |

Table C.7: Summary of probability scores tradable inflation with low intermediate import.

| Model | Lag | Reference | Reference <br> Regime | Model <br> Regime <br> (Normal) | Model <br> Regime <br> (Low) | Model <br> Regime <br> (High) |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | 3 | US <br> dollar | Normal <br> Low <br> High | 0.32 |  | 0.32 |

## Comparison of Probability Scores for Index and Excluded Index

Table C.8: Probability scores for the most relevant foreign exchange indicator by inflation series in each regime.

| Inflation Group | High Regime <br> of Inflation | Low Regime <br> of Inflation | Normal Regime <br> of Inflation |
| :--- | :---: | :---: | :---: |
| Overall | Euro (High) | Euro (Low) | US dollar (Normal) |
|  | $(0.00)$ | $(0.30)$ | $(0.28)$ |
| Tradable | Basket (High) | US dollar (Low) | US dollar (Normal) |
|  | $(0.00)$ | $(0.33)$ | $(0.27)$ |
| Nontradable | Euro (High) | US dollar (Normal) |  |
| High int. import | Euro (High) | $(0.31)$ | US dollar (Low) |
|  | Basket (High) | US dollar (Normal) |  |
|  | $(0.01)$ | $(0.23)$ | $(0.17)$ |
| Low int. import | Euro (High) | Euro (Normal) |  |
|  | $(0.04)$ | $(0.35)$ |  |
| Tradable with | Euro (High) | Euro (Low) | Euro (Normal) |
| high int. import | $(0.13)$ | $(0.22)$ | $(0.34)$ |
| Tradable with | Euro (High) | US dollar (Low) | Euro (Normal) |
| low int. import | Basket (High) | Euro (Low) | Basket (Normal) |
|  |  | Basket (Low) |  |
|  | $(0.08)$ | $(0.32)$ | $(0.30)$ |

Notes: The corresponding probability scores and regimes of reference indicators are given in parenthesis.

Table C.9: Probability scores for the most relevant foreign exchange indicator by inflation series in each regime (excluded index).

| Inflation Group | High Regime of Inflation | Low Regime of Inflation | Normal Regime of Inflation |
| :---: | :---: | :---: | :---: |
| Overall | $\begin{gathered} \text { Euro (High) } \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} \text { Euro (Low) } \\ (0.37) \\ \hline \end{gathered}$ | $\begin{gathered} \text { Euro (Normal) } \\ (0.37) \end{gathered}$ |
| Tradable | $\begin{gathered} \text { Euro (High) } \\ (0.11) \\ \hline \end{gathered}$ | US dollar (Low) <br> (0.20) | $\begin{gathered} \text { US dollar (Normal) } \\ \text { Euro (Normal) } \\ (0.27) \end{gathered}$ |
| Nontradable | $\begin{gathered} \text { Euro (High) } \\ \text { Basket (High) } \\ (\mathbf{0 . 1 8 )} \\ \hline \end{gathered}$ | US dollar (Normal) $(0.32)$ |  |
| High int. import | $\begin{gathered} \text { Basket (High) } \\ (0.01) \\ \hline \end{gathered}$ | $\begin{gathered} \text { US dollar (Low) } \\ (\mathbf{0 . 1 3 )} \end{gathered}$ | US dollar (Normal) (0.10) |
| Low int. import | $\begin{gathered} \text { Euro (High) } \\ (0.03) \\ \hline \end{gathered}$ | $\begin{gathered} \text { Euro (Low) } \\ (0.34) \\ \hline \end{gathered}$ | $\begin{gathered} \text { Euro (Normal) } \\ (0.31) \end{gathered}$ |
| Tradable with high int. import | $\begin{gathered} \text { Euro (High) } \\ \text { Basket (High) } \\ (\mathbf{0 . 0 2 )} \\ \hline \end{gathered}$ | US dollar (Low) $(0.14)$ | US dollar (Normal) (0.11) |
| Tradable with low int. import | $\begin{gathered} \text { Euro (High) } \\ \text { Basket (High) } \\ (0.08) \end{gathered}$ | US dollar (Low) <br> Euro (Low) <br> Basket (Low) (0.32) | Euro (Normal) Basket (Normal) (0.30) |

Notes: The corresponding probability scores and regimes of reference indicators are given in parenthesis.

## D Appendix D

Figures for Reference Variables


Figure D.1: Classification of US dollar.
Notes: The top panel shows US dollar (\%, annual change). The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.2: Classification of Euro.
Notes: The top panel shows Euro (\%, annual change). The second, third and fourth panels show the smoothed probabilities for high (state 1), low (state 2) and normal (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other tates, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.

## —— Basket - State 1 - State 2 . State 3



Figure D.3: Classification of Basket.
Notes: The top panel shows Basket (\%, annual change). The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.4: Classification of REER (CPI based).
Notes: The top panel shows REER (CPI based) (\%, annual change). The second, third and fourth panels show the smoothed probabilities for low (state 1), high (state 2) and normal (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at he top panel is marked


Figure D.5: Classification of REER (PPI based).
Notes: The top panel shows REER (PPI based) (\%, annual change). The second, third and fourth panels show the smoothed probabilities for ow (state 1), high (state 2) and normal (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


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Figure D.6: Classification of OECD inflation.
Notes: The top panel shows OECD inflation (\%, annual change). The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.






Figure D.7: Classification of OECD-Europe inflation. Notes: The top panel shows OECD-Europe inflation (\%, annual change). The second, third and fourth panels show the smoothed probabilities
for low (state 1), normal (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.8: Classification of import prices (US dollar).
Notes: The top panel shows import prices (US dollar) (\%, annual change). The second and third panels show the smoothed probabilities for high (state 1) and low (state 2) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.9: Classification of import prices (TL).
Notes: The top panel shows import prices (TL) (\%, annual change). The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.





Figure D.10: Classification of import volumes.
Notes: The top panel shows import volumes (\%, annual change). The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.



Figure D.11: Classification of export prices (US dollar). Notes: The top panel shows export prices (US dollar) (\%, annual change). The second and third panels show the smoothed probabilities for
high (state 1) and low (state 2) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.12: Classification of export prices (TL).
Notes: The top panel shows export prices (TL) (\%, annual change). The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at he top panel is marked




Figure D.13: Classification of export volumes.
Notes: The top panel shows export volumes (\%, annual change). The second, third and fourth panels show the smoothed probabilities for high (state 1), low (state 2) and normal (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all he other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.14: Classification of export/import prices (US dollar).
Notes: The top panel shows export/import prices (US dollar) (\%, annual change). The second, third and fourth panels show the smoothed probabilities for low (state 1), normal (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.




Figure D.15: Classification of export/import prices (TL). Notes: The top panel shows export/import prices (TL) (\%, annual change). The second, third and fourth panels show the smoothed probabilities
for high (state 1), normal (state 2) and low (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.

—— state 1


——state


Figure D.16: Classification of export/import volumes.
Notes: The top panel shows export/import volumes (\%, annual change). The second, third and fourth panels show the smoothed probabilities or normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.17: Classification of fuel prices.
Notes: The top panel shows fuel prices (\%, annual change). The second, third and fourth panels show the smoothed probabilities for high (state 1), low (state 2) and normal (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.18: Classification of commodity prices.
Notes: The top panel shows commodity prices (\%, annual change). The second, third and fourth panels show the smoothed probabilities for high (state 1), low (state 2) and normal (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at he top panel is marked


Figure D.19: Classification of world import prices.
Notes: The top panel shows world import prices (\%, annual change). The second, third and fourth panels show the smoothed probabilities for high (state 1), low (state 2) and normal (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest among all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.

$—$ state 1

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Figure D.20: Classification of world import volumes.
Notes: The top panel shows world import volumes (\%, annual change). The second, third and fourth panels show the smoothed probabilities for normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest mong all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.21: Classification of world export prices.


Figure D.22: Classification of world export volumes.
Notes: The top panel shows world export volumes (\%, annual change). The second, third and fourth panels show the smoothed probabilities or normal (state 1), low (state 2) and high (state 3) regimes, respectively. Additionally, if the smoothed probabilities of a state is highest mong all the other states, then it is shown in shaded region. Moreover, if the smoothed probabilities are higher than 0.5 , the corresponding data at the top panel is marked.


Figure D.23: Classification of industrial production.

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[^2]:    ${ }^{1}$ Trade openness ratio $=($ exports + imports $) /$ total supply
    ${ }^{2}$ Dixon et al. (2004) and Johnson (2017) use commodity based while other two studies use sector level data in computing tradable and non-tradable goods and services price indices.
    ${ }^{3}$ These studies uses sector level data in computing tradable and non-tradable CPI.
    ${ }^{4}$ The literature, on the other hand (including those referred above), focusing on cross-country analysis use sector-level data and use either share of sectors in value added, factor shares or total employment in aggregating tradable/non-tradable price index. Tradable/non-tradable indices may be cross-country comparable but their link with the domestic official CPI indices may not be straightforward.
    ${ }^{5}$ https://www.wto.org/english/res_e/statis_e/miwi_e/all_Profiles_e.pdf
    ${ }^{6}$ https://www.wto.org/english/res_e/statis_e/miwi_e/TR_e.pdf

[^3]:    ${ }^{7}$ Also, Çiftçi \& Yılmaz (2018) show that the inflation persistence and exchange rate pass-through to consumer prices are more prominent in the regime with sizeable import price shock.

[^4]:    ${ }^{8}$ COICOP 1999 - CPA 2008 corresponding table. (http://ec.europa.eu/eurostat/ramon/miscellaneous/index.cfm?TargetUrl=DSP_COICOP_1999_CPA_2008)
    ${ }^{9}$ Classification of goods and services based on sectoral trade openness rates involves some limitations. In particular, the non-existence of item-level production data is a significant issue in the analysis. For the detailed discussion see Dixon et al. (2004).
    ${ }^{10}$ Dixon et al. (2004) and Johnson (2017).
    ${ }^{11}$ For example see De Gregorio et al. (1994) and Piton (2017).

[^5]:    ${ }^{12}$ Examination of Tables 1 and 2 shows that although the export/total supply criteria suggests more items should be included in tradable goods and services, considering the weight of those excluded items in the consumer basket, the results will not change significantly.

[^6]:    ${ }^{13}$ Table 3 reports weights of different groups of items in 2020 consumer basket. Shares of respective groups can be analyzed from Tables B. 1 and B. 2 in Appendix B.

[^7]:    ${ }^{14}$ For an excellent introduction to MS models, see Hamilton (1994).
    ${ }^{15}$ Details about MS models are given in Appendix A.

[^8]:    ${ }^{16}$ Estimation results including AIC, BIC and RCM values are available upon request.

[^9]:    ${ }^{17}$ Figures obtained from the estimation of MS models with the smoothed probabilities for each reference series (annual change of monthly series) are reported in Appendix D.
    ${ }^{18}$ Basket is a weighted average of US dollar and Euro, in which currencies are assigned equal weights.

[^10]:    ${ }^{19}$ The results for the sub-period analysis are available upon request.

[^11]:    ${ }^{20}$ There are several reasons why in practice they are not equalized, including not covering all countries in world trade, measurement errors and incompleteness of the data (WTM (2019)).

[^12]:    ${ }^{21}$ To analyze the role that the energy items in the consumer basket plays the following 4 -digit items with total weight of 10.5 percent are excluded from the consumer basket: 0451-Electricity ( 2.87 percent), 0452-Gas (2.36 percent), 0454-Solid fuels ( 0.79 percent), 0722-Fuels and lubricants for personal transport equipment ( 4.49 percent). In fact, 0451-Electricity and 0452-Gas items are excluded from nontradable index. However, 0454-Solid fuels and 0722 -Fuels and lubricants for personal transport equipment items are excluded from tradable index. Moreover, 0451-Electricity item is excluded from low intermediate import index, while the other three items are excluded from high intermediate import index.

[^13]:    Notes: OECD-Total CPI index covers 37 OECD countries, obtained from OECD.Stat (2020).

