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COVID-19 SHOCK: PASS-THROUGH TO CONSUMER PRICES IN TUNISIA[1]

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Abstract

In this paper, we evaluate the pass-through of the COVID-19 shock on international prices and trade policy to consumer prices in Tunisia. Specifically, we evaluate the extent to which changes in import unit values, tariffs, non-tariff measures, and new export restrictions imposed by Tunisia's partner countries during COVID-19 are transmitted into consumer prices in Tunisia. Using monthly data from January 2018 to December 2020, a pass-through equation is estimated using sectoral panel data at the retail-product level, and we apply linear panel data techniques that account for unobserved heterogeneity in the dimensions of the panel. We augment the empirical specification with factors related to the current macroeconomic environment derived from the COVID-19 outbreak and persistence. The results provide important insights for Tunisian policymakers.

Keywords: COVID-19; trade policy; Tunisia; inflation; pass-through; imports.
JEL Classifications: F10; F14.

ملخص

في هذه الدراسة، نقيم آثار صدمة فيروس كورونا (كوفيد-19) على الأسعار الدولية وسياسات التجارة وتأثيرها على الأسعار للمستهلكين في تونس. ونقيم، على وجه الخصوص، مدى تأثير التغييرات في قيم وحدة الاستيراد، والتعريفات الجمركية، والتدابير غير الجمركية، والقيود الجديدة التي فرضتها البلدان الشريكة لتونس على التصدير أثناء جائحة فيروس كورونا (كوفيد-19)، وتأثير ذلك على الأسعار للمستهلكين في تونس. وباستخدام البيانات الشهرية من شهر يناير 2018 إلى ديسمبر 2020، تم تقدير معادلة أثر الجائحة باستخدام البيانات القطاعية على مستوى منتجات التجزئة وتطبيق تقنيات البيانات الخطية التي تراعي عدم التجانس غير الملحوظ في أبعاد اللوحة. ونقوم بزيادة المواصفات التجريبية بإضافة العوامل المتعلقة ببيئة الاقتصاد الكلي الحالية الناتجة عن تفشي جائحة فيروس كورونا (كوفيد-19) واستمرارها. توفر النتائج رؤى مهمة لصانعي السياسات التونسيين.

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1. Introduction

The COVID-19 pandemic, along with the associated lockdowns and various other policies implemented to deal with the shock, had an impact on final consumer prices. International pressure on consumer prices is channeled through three different mechanisms. First, COVID-19-related supply disruptions and the strong demand from consumers stockpiling food, medical supplies, personal care products, and cleaning products led to a substantial increase in the prices of these goods. Second, the price surge on these products increased with the trade policy measures enacted by many countries, essentially on food, food-related products, and COVID-19-related products. These policies could escalate to a bigger price increase in food-dependent countries like Tunisia. A recent study by Espitia, Rocha, and Ruta (2020) shows that in the quarter following the outbreak of the pandemic, the global export supply of food decreased between six and 20 percent and global prices increased between two and six percent on average. Export restrictions would amplify the shock by a factor of three, with world food prices rising by up to 18 percent on average.

Third, costs continue to climb, particularly the cost of freight, as shipping containers and semiconductors remain in short supply; a dynamic that is hurting both production and distribution. According to McKinsey & Co.,[4] the cost of shipping goods across the world's oceans and air routes may stay high for at least one year. Other costs related to trade facilitation measures, such as delays of import and export, could also increase consumer prices.

In this paper, we evaluate the pass-through of the COVID-19 shock on international prices to consumer prices in Tunisia. Specifically, we evaluate the extent to which changes in international prices, exchange rates, and trade policy measures due to COVID-19 were transmitted into consumer prices in Tunisia during 2018 and 2020. A pass-through equation is estimated using sectoral panel data at the retail-product level while controlling for unobserved sectoral heterogeneity. We augment the empirical specification with factors related to the current macroeconomic environment derived from the COVID-19 outbreak and its persistence.

The rest of the paper is organized as follows. Section 2 presents a review of closely related papers, with special attention to those analyzing the Tunisian case. Section 3 presents the modeling framework and the empirical methodology as well as the data sources and some stylized facts. Section 4 outlines the main results, and section 5 includes several robustness checks. Finally, conclusions and policy recommendations are presented in section 6.

2. Literature review

The standard model used to estimate the effect of trade policies or exchange rate movements on retail prices is a pass-through model that distinguishes between domestic and imported varieties (Goldberg and Knetter, 1997). There is much literature estimating the exchange rate pass-through (ERPT), as surveyed in Menon (1995). Those empirical studies mainly find

[4] https://www.bloomberg.com/news/newsletters/2021-03-18/supply-chain-latest-mckinsey-sees-high-freight-costs-lingering.

evidence of incomplete pass-through, especially in countries with low inflation. Similarly, other authors focused on estimating tariff pass-through (Nicita, 2009 for Mexico; Ural Marchand, 2012 for India; and Borraz et al., 2013 for Brazil), who also found incomplete transmission from changes in tariffs to changes in final prices. For the Tunisian case, Baghdadi, Martinez-Zarzoso, and Kruse (2016) show that, on average, tariff pass-through is low (around ten percent) and varies across sectors. With respect to non-tariff measures (NTM), agricultural products are more affected than manufactures. In general, the change in Tunisian tariffs has affected local prices, but the effect is lower in magnitude than that found for other developing countries. This is in part due to imperfect competition and state interventions through subsidies and price controls that prevent the full transmission of changes in international prices and trade policy.

We expand on the model used by Baghdadi et al. (2016) to evaluate the impact of rising international prices – due to COVID-19, newly adopted trade policy measures related to the pandemic, and movements in the exchange rate – on consumer prices in Tunisia. Therefore, we will augment the traditional pass-through specification with factors related to the current macroeconomic environment and derived from the outbreak and persistence of COVID-19.

3. Modeling framework and empirical methodology

The main conceptual framework, based on economic theory, is outlined in sub-section 3.1. Sub-section 3.2 presents the data and some stylized facts, while sub-section 3.3 explores the empirical methodology.

3.1 Modeling Framework

In this section, we present the methodology used to evaluate the changes in international prices and the degree to which these changes translate into changes in domestic prices in Tunisia. We use the retail price data of domestic goods along with producer price data and international prices to estimate a pass-through equation. Retail prices can react only partially to changes in international prices, and the extent to which the transmission is complete depends not only on the changes in trade policies – such as tariff reductions, NTMs (export restrictions from Tunisia's partner countries), or given domestic policies, such as price support and exchange rate policies – but also on exchange rate policies and the specific institutional, economic environment and competition policies. It is possible for retail prices to not fully incorporate changes in border prices if the circumstances in the given country impede or complicate the transmission of the changes. In particular, the lack of substitutes, the impact of transport costs, the influence of competitor prices, and the rigid margins of intermediaries could affect the extent to which reductions in border prices are passed to retail prices. Prices are also affected by the country's competitive conditions. It is also important to note that price transmission also depends on the market shares of production and consumption of the goods. For example, if a country is a large producer or consumer of a given product, it could impact its international price. In the case of Tunisia, which could be considered a small country in economic terms, this should not be an issue.

Another important aspect to be considered is the speed of adjustment. According to World Bank studies for developing countries, changes in the international prices of commodities are passed through to domestic prices within three to six months, depending on the local production situation, access to markets, and import/export logistics. Further, even if markets are fully integrated and well-functioning, the average pass-through ranges between 20-70 percent; meaning that a ten percent change in international prices results in a two to seven percent increase in domestic prices (Nicita, 2009; Ural Marchand, 2012; and Borraz et al., 2013). However, this is probably not the case in countries like Tunisia that have high food subsidies and controlled prices (Baghdadi et al., 2016).

The empirical strategy consists of adapting the framework developed by Goldberg and Knetter (1997) and Campa and Goldberg (2008) and used by Nicita's (2009)[5] and Borraz (2013) to the Tunisian case. We express prices as follows:

$$P_{kt} = PP_{kt}^{\alpha}\big(PI_{kt}(1+\tau_{kt})\big)^{1-\alpha} \quad (1)$$

where P_{kt} is the local price faced by households for good k at time *t*. PI_{kt} denotes the international price in local currency, which means that the import prices are a transformation of the export prices of the trading partners using the exchange rate ($PI=e*Px$, where e is the exchange rate and Px are export prices); τ_{kt} denotes the tariff of good k at period *t*; and PP_{kt} denotes producer prices. Here, α indicates the dominance of local varieties over imported varieties and $(1\text{-}\alpha)$ the importance of international prices, trade policies, and trade costs on local prices. The degree of pass-through is given by $(1\text{-}\alpha)$. The pass-through is complete when α takes the value of zero and changes in border prices are 100 percent passed to retail prices, whereas if $\alpha=1$, the pass-through changes in border prices do not affect retail prices. It's important to note that while the exposition here is in terms of tariffs, the same line of reasoning applies to other trade costs. While Tunisia is one of the few countries that did not apply new import or export restrictions after the COVID-19 outbreak, their trading partners did. Several products were exposed to export restrictions on food, food-related products, and COVID-19 products. Tunisia therefore suffered from these restrictions and was unable to import some essential goods. Some partner countries also reduced or increased their tariffs on these specific products (see Falkendal et al., 2021). Therefore, we will take these changes in trade policies into account in our empirical model. The surge in shipping costs could also be included in these trade costs.

Taking logs of equation (1) we obtain,

$$\ln P_{kt} = \alpha \ln PP_{kt} + (1-\alpha)\ln PI_{kt} + (1-\alpha)\ln(1+\tau_{kt}) \quad (2)$$

Loosening the restrictions imposed on coefficients in (2) and adding sectoral λ_k, and time dummy variables, π_t, the following model is estimated:

[5]We are not able to differentiate by region due to the lack of data on regional retail prices.

$$\ln P_{kt} = \beta_0 + \beta_1 \ln PP_{kt} + \beta_2 \ln REER_t + \beta_3 \ln UV_{kt} + \beta_4 \ln(1 + WTAR_{kt}) + \beta_5 \text{NTM}_{kt} + \beta_6 \text{tunre}_{kt} + \beta_7 \text{Intsh}_{kt} + \beta_8 \text{Pcovr}_{kt} + \lambda_k + \pi_t + \varepsilon_{kt} \quad (3)$$

where ε_{kt} denotes the error term that is assumed to be independently and identically distributed (iid). $REER_t$ is the real effective exchange rate and UV_{kt} denotes import unit values. In addition to trade-weighted tariffs (WTAR_{kt}), the number of NTMs by product are also included as proxies for trade cost in the estimations. Trade-weighted tariffs are preferential tariffs weighted by the product import shares corresponding to each partner country.

NTMs cover restrictions on Tunisian imports from partner countries implemented by Tunisia. The variable *tunre* denotes restrictions imposed on Tunisian imports at the product level by exporters.

Two additional regressors are added as potential candidates for explaining the variation in consumer prices; the first is the share of intermediates imports by sector (*Intsh*) and the second is the COVID-19 related export restrictions applied by Tunisian trading partners (*Pcovr*), which could have contributed to the increase in internal prices. The rest of the variables are the same as in equation (1).

3.2 Data and stylized facts

Data for the consumer price index (CPI) are from the Tunisian National Institute of Statistics, with the base in July 2015 and covering the period from 2018 to May 2021. They are recorded by product according to the Classification of Individual Consumption According to Purpose (COICOP)[6] classification.

Producer prices are from the Tunisian National Institute of Statistics and the Central Bank of Tunisia and are available from November 2015 to December 2020 for prices of agri-food and manufacturing industries, classified into seven sectors and 48 sub-sectors.

Nominal and real effective exchange rates (REER) from January 2015 to April 2021 are available from the Central Bank of Tunisia. An increase represents an appreciation of the local currency. The REER is defined as the nominal effective exchange rate (the value of the local currency against a weighted average of several foreign currencies) divided by a price deflator. The REER is obtained as the average bilateral real exchange rates between the country and each of its trading partners, weighted by the respective market shares of each partner. The REER

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[6] COICOP is a classification developed by the United Nations Statistics Division to classify and analyze individual consumption expenditures incurred by households, non-profit institutions serving households, and general government according to their purpose, which includes categories such as clothing and footwear, housing, water, electricity, and gas and other fuels.

between two currencies is calculated by multiplying the nominal exchange rate (the cost of buying one euro in dollars, for example) by the price ratio between the two countries.

Tariffs (MFN and preferential) are for the years 2015 and 2016 for all products, unweighted ad-valorem equivalent (AVE), and number product lines with NTMs. Data for NTM applied by Tunisia for the year 2018 are from the MacMap database with information on the NTM code by type at the six-digit level HS from the MacMap database.

Monthly bilateral import data by product for 2018-2020 are from Tunisian Customs.

International prices are approximated using import unit values, i.e., import value divided by import volume from the Tunisian Customs Authorities, and are available on the website of the Tunisian National Institute of Statistics. Unit values are calculated in US dollar per kilogram. Since import values include cost, insurance, and freight (c.i.f.), such trade costs are implicitly controlled for in the regression analysis. As in the case of tariffs, import-weighted unit values were calculated based on the respective commodity's import share. Unit values will be converted into Tunisian dinar using exchange rates obtained from the Central Bank of Tunisia. Other sources were also considered, such as the USDA PSD database,[7] the FAOSTAT database from FAO,[8] the World Bank commodity markets database,[9] and the US Bureau of Labor Statistics.[10]

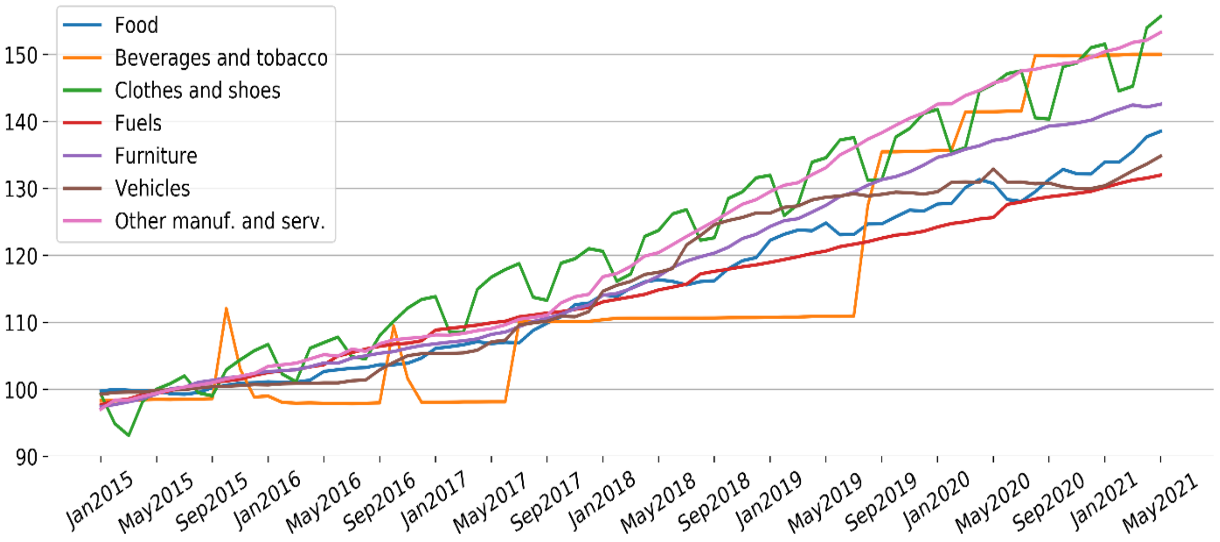
Retail prices are available for more than 140 product groups. However, due to a lack of recording in the years for which tariff data are available and some issues of concordance with the trade data (HS classification), we are left with 42 items. Those have to be linked to industrial prices, available for 70 product groups. Since there is no available official conversion table that allows us to merge industrial prices, trade and tariff data, and retail prices, we manually constructed such concordances.[11] Tariff data will be retrieved in the combined harmonize system (HS) nomenclature and will be converted to HS 1996 before they could be merged with the trade and non-tariff data.

Data on COVID-19-related trade policies and export restrictions applied by Tunisian trading partners are taken from the International Trade Centre Temporary Trade Measures, and the number of new trade interventions related to Tunisian imports and enacted by trading partners impacting Tunisian imports is constructed by the Global Trade Alert.

[7] https://apps.fas.usda.gov/psdonline/
[8] http://www.fao.org/faostat/
[9] https://www.worldbank.org/en/research/commodity-markets
[10] https://www.bls.gov
[11] Available upon request from the authors.

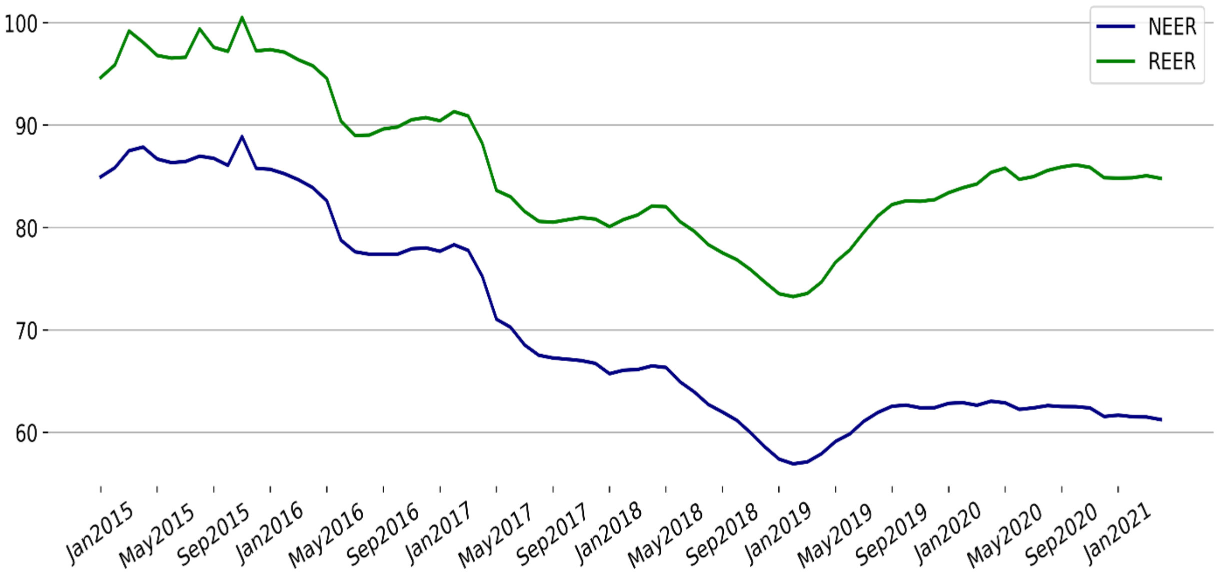
Figure 1 shows the evolution of consumer prices over time for broad selected categories. It can be observed that food product prices in particular experienced an increase during April-May 2020 and increased again after the summer of 2020.

Figure 1. Evolution over time of consumer prices (monthly data)



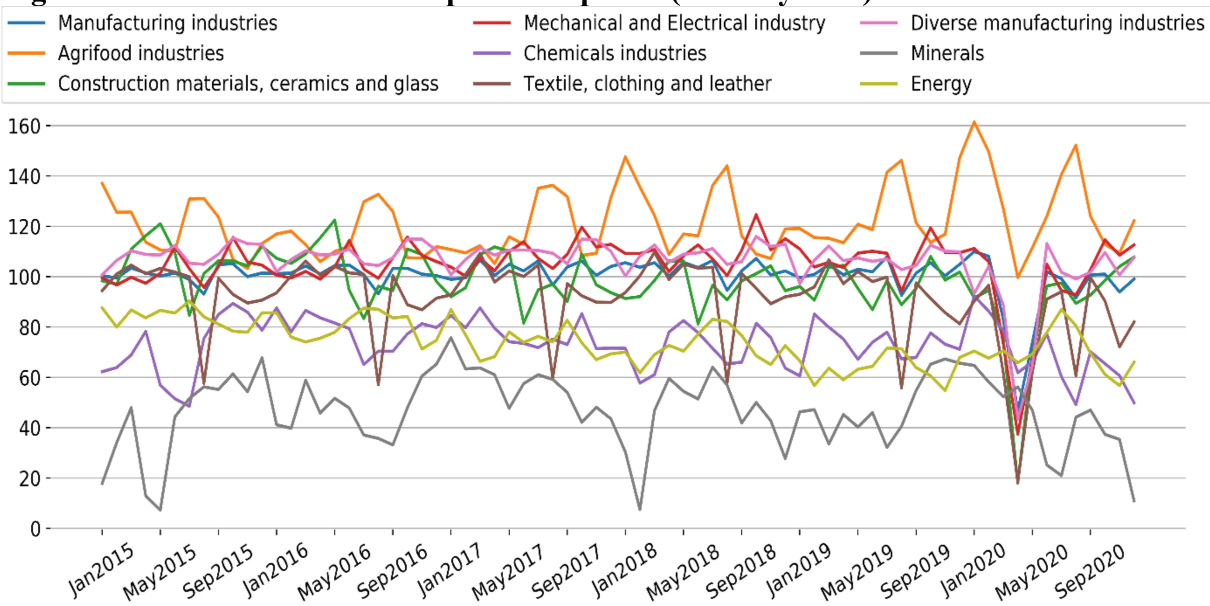
Source: Authors' elaboration using data from the Tunisian National Institute of Statistics.

Figure 2. Evolution over time of nominal and real effective exchange rates (monthly data)



Source: Authors' elaboration using data from the Tunisian Central Bank. NEXCHR denotes nominal and REXCH denotes REERs.

Figure 3. Evolution over time of producer prices (monthly data)



Figures 2 and 3 show the evolution over time of the nominal and real exchange rate and the evolution of producer prices, respectively. The REER fell gradually from January 2017 to May 2019, experienced a slight increase, and later stabilized during 2020. The evolution of producer prices reflects some expected seasonal variations but became more erratic during the pandemic. There was a sharp decrease in producer prices in April 2020, particularly for textiles, clothes, and leather, but also for energy and several manufacturing industries.

Summary statistics and cross-correlations between the variables considered in the empirical model are presented in Table 1 below.

Table 1. Summary statistics and cross-correlations

Variable	Obs	Mean	Std. Dev.	Min	Max
lnCPI	1149	4.824	0.081	4.634	5.039
lnPPI	1149	4.558	1.067	-1.153	6.599
lnREER	1149	4.391	0.050	4.294	4.456
LnUV	1149	4.944	0.090	4.618	5.146
lnWTAR	1149	3.130	1.336	0.157	6.933
Lntunre	1149	8.503	1.334	4.127	10.231
Intermediate goods shares (Insth)	1149	0.539	0.311	0.00003	1
Post-COVID restrictions (Pcovr)	1149	0.189	1.185	0	13
lnNTMs	1149	4.101	1.429	1.792	6.592

Correlations	lnCPI	lnPPI	lnREER	lnuv	lnWTAR	lntunre	intsh	pcovr	lnNTMs
lnCPI	1								
lnPP	-0.072	1							
lnREER	0.219	0.029	1						
lnUV	0.389	0.041	0.047	1					
lnWTAR	-0.239	0.042	-0.027	-0.242	1				
lntunre	-0.383	-0.077	-0.002	-0.266	0.640	1			
Intsh	-0.037	0.141	0.003	0.011	0.403	-0.017	1		
Pcovr	-0.006	-0.017	0.159	0.037	0.125	0.095	0.019	1	
lnNTMs	-0.037	-0.100	0.002	0.286	0.009	0.175	0.009	-0.006	1

Source: Authors' elaboration. Ln denotes natural logs, CPI is the consumer price index, PPI denotes producer prices, REER is real effective exchange rate, UV denotes import unit-values, WTAR denotes import-weighted tariffs and tunre denotes restrictions imposed to Tunisian imports by exporters. Intsh denote the share of intermediate inputs and Pcovr is COVID-19-related export restrictions. NTMs denotes non-tariff measures.

3.3 Empirical methodology

The methodology is based on the estimation of econometric models using state-of-the-art panel data methods applied to the sectoral data collected from the sources mentioned above. In particular, the pass-through equation given by equation (3) is estimated using a log-log linear model that accounts for unobserved heterogeneity in the dimensions of the panel, that is, sectoral and time dimensions. For comparability purposes, we also present the results for a pooled Ordinary Least Squares (OLS) estimation in the next section. After considering that some effects could be absorbed by the time dummy variables, we then add sequentially time-invariant sectoral effects[12] and monthly-year fixed effects. In addition, we estimate the model considering heterogeneous coefficients before and after the outbreak of COVID-19:

$$\ln P_{kt} = \beta_0 + \beta_1 \ln PP_{kt} + \beta_2 \ln REER_{kt} + \beta_3 \ln uv_{kt} + \beta_4 \ln(1 + WTAR_{kt}) + \beta_5 \mathrm{NTM}_{kt} + \beta_6 \mathrm{Intsh}_{kt} + \beta_7 \mathrm{Pcovr}_{kt} + COVID_t * (\gamma_0 + \gamma_1 \ln PP_{kt} + \gamma_2 \ln REER_{kt} + \gamma_3 \ln uv_{kt} + \gamma_4 \ln(1 + WTAR_{kt}) + \gamma_5 \mathrm{NTM}_{kt} + \gamma_6 \mathrm{Intsh}_{kt} + \gamma_7 \mathrm{Pcovr}_{kt}) + \varepsilon_{kt} \quad (4)$$

[12] The unobserved sectoral effects can be considered random or fixed, depending on whether the time-invariant component of the error term is correlated with the other covariates. A Haussman test cannot reject the null hypothesis of orthogonality between the former and the latter and hence a random effect approach is selected.

4. Main results

The main results are presented in tables 2 and 3. Table 2 shows the estimates obtained when including all sectoral categories and Table 3 presents the results for agricultural and manufacturing sectors separately. The results obtained from estimating model (3) – which extended the theoretical model with the share of intermediate inputs imported by sector and with a measure of post-COVID-19 restrictions – indicate that none of these variables seem to play an important role in explaining the short-run variation in the CPI. Column (1) in Table 2 shows the results for the pooled OLS model, which does not account for sectoral unobserved heterogeneity. The results shown in column (2) present the estimation of model (3) flowing a random effects approach, hence the model is estimated by feasible generalized least squares (FGLS). The model in column (2) is preferred since it accounts for the panel data structure and for time-invariant sectoral unobserved heterogeneity. In column (3), an alternative proxy for NTMs is used (that is, the restrictions imposed by exporters to Tunisia) which does not provide any improvement with respect to NTMs. In column (4), a random effects specification is estimated that also includes the monthly-year dummies. We discuss the results presented in columns (2) and (4).

The REER presents the expected sign and magnitude in column (2), indicating a pass-through of around 42 percent. In column (4), however, once year-monthly dummies are added to the model, the exchange rate effect is absorbed by the dummies. The producer price index is not statistically significant in any of the specifications that control for unobserved heterogeneity, indicating that the variation of CPI seems to be affected by changes in PP. Concerning international prices proxied by import unit values (*lnUV*), a slightly lower pass-through as for exchange rate is also found in models (2) and (3), but it decreases in magnitude and loss significance in (4). Differently, the tariff pass-through (*lnWTAR*), statistically significant in all models, is much lower in magnitude, whereas no significant effect is found for NTMs. Export restrictions imposed by Tunisia's partners (*lntunre*) do show a non-significant effect on retail prices. Moreover, the post-COVID-19 restrictions imposed by Tunisian trading partners do not affect the CPI. Finally, the share of intermediate goods is also found to be non-statistically significant after controlling for sectoral heterogeneity, but it could be that this factor has a heterogeneous slope. This is investigated in Table 3.

Table 2. Consumer prices and their determinants

Dependent Variable: lnCPI EXPLANATORY VARIABLES	(1) OLS	(2) Sector RE	(3) Sector RE	(3) Sector RE&Time FE
lnPP	-0.027***	-0.003	-0.003	-0.003
	(0.004)	(0.002)	(0.002)	(0.002)
lnREER	0.435***	0.423***	0.424***	
	(0.062)	(0.027)	(0.027)	
LnUV	0.447***	0.382***	0.381***	0.042
	(0.035)	(0.017)	(0.017)	(0.026)
lnWTAR	0.002	0.005***	0.006***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Lntsh	0.027***	0.013	0.013	0.014
(Share_of_intermediates)	(0.009)	(0.011)	(0.011)	(0.010)
post_covid_restrictions	-0.002	0.001	0.001	0.001
(Pcovr)	(0.003)	(0.001)	(0.001)	(0.002)
LnNTMs	-0.002	0.001		0.006
	(0.002)	(0.010)		(0.010)
LnTunre			-0.016	
			(0.010)	
Observations	755	755	755	755
R-squared	0.266	0.232	0.285	0.212
Sector RE		Yes		
Year& Monthly FE				Yes
Hausman Test		Chi2=2.15	Prob=0.4	

Notes: Robust standard errors, cluster at the sectoral level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Given that some previous research shows that sectoral differences in the effects could be relevant, Table 3 shows separated results for agricultural and non-agricultural products with sectoral random effects (in columns 1 and 2) and with sectoral random effects and time FE (in columns 3 and 4). The result in column (1) shows that the exchange rate pass-through is higher for food and agricultural products at around 60 percent, similar to the one obtained for import unit values (proxy for international prices). The coefficient on the tariff variable is significant in all models and has the expected positive sign, and the magnitude is significantly higher for food and agricultural products. Differently, NTMs seem to increase consumer prices only for agricultural and food products (columns 1 and 3), but not for manufacturing products. The share of imported intermediate inputs shows a significant positive effect in column (4), indicating that prices are higher for sectors that import more intermediate inputs.

Table 3. Separated results for agricultural and non-agricultural products

Dependent Variable: ln CPI	Food &Agriculture	Manuf &Services	Food &Agriculture	Manuf &Services
EXPLANATORY VARIABLES	(1)	(2)	(3)	(4)
lnPP	-0.011	-0.003*	-0.003	-0.003***
	(0.012)	(0.002)	(0.007)	(0.001)
lnREER	0.588***	0.377***		
	(0.064)	(0.125)		
Ln UV	0.429***	0.359***	0.225**	0.022
	(0.052)	(0.104)	(0.100)	(0.035)
lnWTAR	0.024***	0.005*	0.023***	0.006**
	(0.006)	(0.003)	(0.007)	(0.003)
Lntsh (Share_of_intermediates)	-0.147***	0.019	-0.153***	0.023***
	(0.039)	(0.011)	(0.035)	(0.008)
post_covid_restrictions (Pcovr)	-0.002	0.004	-0.004	0.005
	(0.002)	(0.005)	(0.003)	(0.006)
lnNTMs	0.025***	0.007	0.032***	0.005
	(0.010)	(0.012)	(0.013)	(0.013)
Observations	180	575	180	575
Number of Sectors	5	16	5	16
R2	0.799	0.238	0.827	0.225
Sectoral RE	yes	Yes		
Year-Month FE			yes	yes

Notes: Robust standard errors, cluster at the sectoral level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Next, we created a dummy variable that takes the value of one after the COVID-19 outbreak and included it as a regressor. We also interacted it with the main explanatory variables in our model[13] as specified in model (4) in the previous section. The results are shown in Table 4. Column (1) shows the results obtained when adding a COVID-19 dummy variable in the same specification as in columns (1) and (2) of Table 3. The results are similar, except for the coefficient of the REER, which decreases in magnitude and is not statistically significant for manufactures and services in column (2). This indicates that the pass-through is around 42 percent for agricultural and food products and non-significant for manufactures and services. The COVID-19 dummy is statistically significant and positively signed, indicating that prices were about three percent (four percent) higher during COVID-19 for agriculture (other sectors) in comparison to the previous months (period from January 2018 to February 2020).

Finally, in columns (3) and (4), we interacted the COVID-19 dummy variable with all the explanatory variables; in (3) for agricultural and food products and in (4) for manufactures and services. The results indicate that the exchange rate pass-through significantly increased during the COVID-19 outbreak period (March-December 2020) in comparison to the previous 26 months; becoming around 50 percent for manufactures and services during the pandemic, and remaining the same for the agricultural and food sector. Differently, the import unit values coefficient is only statistically significant in the pre-pandemic period in (3) and (4). For the

[13] We would like to thank Samir Ghazouani for suggesting this additional specification.

weighted tariffs, the effects do not differ significantly pre- and post-pandemic. Concerning non-tariff measures, the effect is only significant in the pre-pandemic period for food and agriculture in column (3).

Table 4. Results before and after COVID-19

Dependent Variable ln CPI EXPLANATORY VARIABLES	(1) Food& Agriculture	(2) Manuf& Services	(3) Food& Agriculture	(4) Manuf& Services
lnPP	-0.011	-0.002	-0.014	-0.021**
	(0.010)	(0.002)	(0.013)	(0.007)
covid19*c.lnPP			-0.006	-0.026***
			(0.007)	(0.006)
lnREER	0.421***	0.140	0.425***	0.211*
	(0.043)	(0.104)	(0.048)	(0.105)
covid19*c.lnREER			0.463	0.482**
			(0.455)	(0.174)
Lnuv	0.376***	0.313***	0.379***	0.466***
	(0.043)	(0.088)	(0.042)	(0.096)
covid19*c.lnuv			0.747	0.230
			(0.474)	(0.154)
lnWTAR	0.024***	0.007***	0.025***	0.006
	(0.006)	(0.003)	(0.007)	(0.014)
covid19*c.lnWTAR			0.028***	0.004
			(0.007)	(0.010)
Share_of_intermediates	-0.146***	0.024**	-0.143***	0.063
	(0.036)	(0.011)	(0.046)	(0.057)
covid19*c. intermediates			-0.170***	0.003
			(0.030)	(0.058)
post_covid_restrictions	-0.003	0.001	0.000	0.000
	(0.002)	(0.004)	(0.000)	(0.000)
lnNTMs			-0.003	-0.004
			(0.002)	(0.003)
covid19*c.lnNTMs	0.027***	0.001	0.029**	-0.007
	(0.010)	(0.012)	(0.012)	(0.013)
covid19	0.029***	0.040***		
	(0.005)	(0.014)		
Observations	180	575	180	575
R-squared	0.319	0.908	0.818	0.913
product RE	Yes	Yes	Yes	Yes

Notes: Robust standard errors, cluster at the sectoral level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1. COVID-19 is a dummy variable that takes the value of one after March 2020, zero otherwise. This variable is interacted with each regressor and * denotes interaction.

5. Robustness checks

In this section, we present two robustness checks.

First, we experiment with heterogeneous coefficients for the tariff pass-through and for the exchange rate. The results are presented in Table A.1 in the Appendix. In column (1), we observe that the positive pass-through of an increase in tariffs is particularly present and significant in the case of fish and seafood (0.025), fruits (0.046), and vegetables (0.030). In the case of manufacturing products, there is a significant and positive tariff pass-through into the prices of footwear (0.074), motor cars (0.066), and motorcycles (0.049). The REER pass-through into consumer prices is significant and positive for bread and cereals (0.431), fish and seafood (0.461), fruit (0.565), milk, cheese, and eggs (0.365), oil and fats (0.432), and vegetables (0.578). In the case of manufacturing products, there is a significant and positive REER pass-through for all products, with higher magnitudes for fuels and lubricants for personal transport (0.573), major household appliances (0.623), and motor cars (0.579).

Second, since the literature shows that changes in the international prices of commodities are passed through to domestic prices within three to six months depending on the local production situation, access to markets…etc., we present estimations in Table A.2 taking three-month lags of the relevant variables for all sectors in column (1), for agrifood products in (2), and for manufactures and services in (3). In general, the results remain the same. They confirm that tariff pass-through to prices with lagged effects is also in place. They show that real exchange rate pass-through into consumer price is strongly significant and positive. Similarly, import unit values significantly increase consumer prices in all three estimations. Moreover, the share of intermediate goods and the existence of COVID-19-related restrictions remain in general non-significant, whereas NTMs on Tunisian imports result in increasing consumer prices for food and agricultural goods (column 2).

6. Conclusions

This study estimates COVID-19 pass-through effects for the Tunisian economy using data from January 2018 to December 2020. The main results indicate that changes in tariffs are only partially transmitted to changes in retail prices, with an average tariff pass-through of 0.005 percent. Findings also show that changes in producer prices are barely impacting consumer prices, while import unit prices have a positive and significant effect on them. However, this significant effect is only present in the pre-pandemic period. Moreover, export restrictions imposed by Tunisia’s partners are not translated into changes in consumer prices in Tunisia. However, non-tariff measures result in an increase of consumer prices rather strongly, particularly in agricultural and food products. Finally, the real exchange rate pass-through is positive and significant, specifically for agricultural and food products and with a significantly higher magnitude during the pandemic, reaching a pass-through of almost 50 percent. This indicates that changes in the REER translated into changes in domestic prices more heavily during the period from March 2020 to December 2020 than during the previous 26 months.

Additionally, the effect of changes in the exchange rate and tariffs shows product heterogeneity, indicating that a more detailed analysis should be desirable in the near future when a longer post-COVID-19 period of data becomes available.

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Table A.1 Heterogeneous coefficients for tariffs and exchange rates

COICOP Categories:	**ln (1+WTAR)**	**ln REER**
Animal drawn vehicles (D)	0.010	0.289**
	(0.009)	(0.147)
Beer (ND)	-0.070***	0.241
	(0.022)	(0.147)
Bicycles (D)	0.068**	0.294**
	(0.030)	(0.147)
Bread and cereals (ND)	-0.016***	0.431***
	(0.004)	(0.099)
Coffee, tea and cocoa (ND)	-0.010	0.358***
	(0.007)	(0.108)
Fish and seafood (ND)	0.025***	0.461***
	(0.008)	(0.098)
Fruit (ND)	0.046***	0.565***
	(0.009)	(0.119)
Fuels and lubricants for personal transport	0.013	0.573***
	(0.014)	(0.133)
Major household appliances electric or not	0.031	0.623***
	(0.020)	(0.161)
Meat (ND)	-0.003	0.369***
	(0.006)	(0.106)
Milk, cheese, and eggs (ND)	-0.006	0.365***
	(0.007)	(0.106)
Mineral waters, soft drinks	0.020*	0.405***
	(0.011)	(0.100)
Motor cars (D)	0.066***	0.579***
	(0.011)	(0.124)
Motorcycles (D)	0.049**	0.211
	(0.025)	(0.192)
Oils and fats (ND)	0.004	0.432***
	(0.006)	(0.098)
Shoes and other footwear (SD)	0.074***	0.630***
	(0.020)	(0.158)
Small electric household appliances (SD)	0.028	0.563***
	(0.018)	(0.131)
Spirits (ND)	-0.062***	0.287**
	(0.017)	(0.126)
Sugar, jam, honey, chocolate and confectionery (ND)	-0.010	0.354***
	(0.011)	(0.109)
Vegetables (ND)	0.030***	0.578***
	(0.011)	(0.132)
Wine (ND)	-0.047***	0.252*
	(0.015)	(0.141)
Observations	755	755
R-squared	0.842	0.871

Notes: Robust standard errors, cluster at the sectoral level, in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. WTAR=Import-weighted tariffs, REER=real effective exchange rate of the Tunisian Dinar with respect to its main trading partners.

Table A.2 Results using predetermined variables (three-month lags)

Dependent Variable: ln CPI	(1) All Sectors	(2) Food&Agriculture	(3) Manuf&Services
EXPLANATORY VARIABLES			
Ln PP = L3	-0.003	-0.020***	-0.003
	(0.002)	(0.008)	(0.003)
Ln REER = L3	0.345***	0.521***	0.297***
	(0.089)	(0.051)	(0.113)
Ln UV = L3	0.362***	0.409***	0.341***
	(0.073)	(0.055)	(0.093)
ln WTAR = L3	0.005**	0.023***	0.006**
	(0.002)	(0.007)	(0.003)
intsh = L3	0.012	-0.137***	0.018
	(0.014)	(0.037)	(0.017)
pcovr = L3	-0.001	-0.003	-0.002
	(0.002)	(0.003)	(0.003)
lnNTMs = L3	0.002	0.026**	0.001
	(0.011)	(0.011)	(0.012)
Observations	691	165	526
product FE	No	Yes	Yes

Notes: Robust standard errors, cluster at the sectoral level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1. =L3 indicates that the variable has been lagged three periods.