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An econometric analysis of the demand for cigarettes in Italy after the introduction of heated tobacco products in 2016

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Abstract

Purpose – This article provides evidence of a long-term structural relationship between demand for heated tobacco products (HTPs) and for combustible cigarettes in a Marshallian demand framework, using data from the Italian market.

Design/methodology/approach – A cointegration-based approach allows to capture the substitution effects between the two products arising for reasons (possibly) other than price.

Findings – The authors find that such a relationship exists and is sufficiently strong to constitute a cointegration.

Social implications – Since a fully consolidated consensus on reduced harm from smokeless tobacco products is absent, symmetric policies on both markets are therefore necessary in terms of regulation and excise incidence to minimize the social cost of substitution and to maximize government revenues, which are a necessary counterpart to negative externalities that arise with smoking both products.

Originality/value – This paper focuses on the Italian market with product specific volume and price data, both for cigarettes and HTPs. Because of the detected relationship, a regulatory trade-off arises in case of a relatively mild regulation on heated-tobacco products: benefits from decreasing demand for combustible cigarettes may be offset by the social cost of increasing consumption of heated tobacco products. Moreover, a milder regulation makes price related policies to curb smoking less effective.

Keywords Combustible cigarettes, Heated-tobacco products, Demand, Substitution, Symmetric policies

Paper type Research paper

1. Introduction

Tobacco control policies in Italy are in place since the 1960s when advertisement for tobacco products was banned [1]. In the 1970s, smoking was banned from some public areas like cinemas, hospitals, schools and public transportations, [2] but as remarked in the study of Gallus *et al.* (2006), it is with the 2005 smoking ban in all indoor public venues that such ban has been effectively enforced, together with the prohibition to sell tobacco products to people under the age [3]. Moreover, in 2006, the Framework Convention of the World Health Organization (WHO) to control smoking was ratified in Italy as well (see Gualano *et al.* (2014) for a thorough discussion on the topic). Despite the effectiveness of the 2005 ban on consumption habits has been questioned on a generalized basis, it is hardly questionable that tobacco control policies have reduced the number of occasions for second-hand smoke and

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contributed to a more favorable environment for quitters, as well as for non-smokers. Nevertheless, despite the large consensus supporting the ban, the Italian Government operated in a framework of substantial inelastic demand, with a low degree of substitutability with other traditional products, and traditionally exploited such a condition to maximize revenues. In fact, as pointed out in Ciccarelli *et al.* (2018), it arises that substitution effects among alternative ways of consuming tobacco are quite frequent in the long-run. Such a substitution historically determined a gradual substitution for other tobacco products by cigarettes, and complementarity rather than substitution arose as a relatively more significant phenomenon [4]. In particular, this insight it makes more apparent that substituting cigarettes by other product is a relatively new phenomenon.

On the other hand, in the recent years, the demand for a new class of products, i.e. the heated tobacco products (HTPs), is growing exponentially in Italy with unclear effects on demand for combustible factory made cigarette (FMC). Whereas the policies aimed at controlling FMC consumption are well developed, this is not the case for HTPs, whose effects on individual and public health are currently under analysis, and a consensus does not exist yet on the topic.

The policies for control of HTPs are still a matter of international debate, and there is no medical and scientific consensus on their toxicity relative to other tobacco products, which makes it virtually impossible at the present time to assess their impact on public health. At a regulatory level, United States (US) Food and Drugs Administration (FDA), based on evidence provided by the manufacturer, only granted the claim of modified risk for a category of smokeless products, opposing the manufacturer's proposal to introduce a claim of reduced harm with respect to smoking combustible cigarettes (See for instance FDA's decision summary MR0000133 issued on July, 7th 2020 as for a HTP). Government policies, so far, have been heterogeneous across countries, and despite a lack of medical evidence on (possibly long-term) consequences on individual health, demand for HTPs surged everywhere they have been launched.

Tobacco-control policies are usually implemented at national or state level, but supranational organizations such as WHO try to steer them in order to coordinate efforts against the smoking epidemic (see Guzmann-Tordecilla *et al.* (2022) for a discussion of this issue and a country-level analysis). Actually, the set of recommendations on tobacco-control policies that are proposed by WHO are the most prominent worldwide. According to the Framework Convention on Tobacco Control (FCTC), tobacco control policies should rely on both price and non-price measures to reduce demand. Moreover, Conference of the Parties – Session 8 (COP8 Decision 22) invited public health authorities to consider potential (and largely unknown) risks associated to consumption of novel tobacco products such as e-cigs and, especially, HTPs, not only in terms of direct harms to health but also in terms of prevention to initiation and exposure. In particular, according to the WHO, HTPs should definitively be treated as tobacco products and, subsequently, regulated as such, including the application of demand-reduction measures. Nevertheless, the extent policies and regulations on cigarettes are extended to HTPs is not homogeneous across countries.

Regulation and taxation of e-cigs and HTPs is currently under consolidation in many countries as such products are at early stages of market penetration. As a consequence, tax burdens, as well, are very heterogeneous across countries. Within the European Union (EU), the HTP excise relative to the average excise of cigarette ranges from 19% in Estonia to 80% in Germany (from 2021). Outside the EU, according to Tobacco Tactics, an independent observatory at the University of Bath, Japan is the largest market for HTP (US$ 8.6 bn), followed by South Korea (US$ 1.6 bn) and Italy (over US$ 1 bn). The excise burden is around 80% of the excise on cigarette, whereas in South Korea the HTP excise, relative to cigarette, is 86%. Within the EU, Italy represents the market with the largest retail value, and the HTP excise amounts to 30% of the excise due on the equivalent number of combustible cigarettes at weighted average price. Equivalence is based on puffs, and the equivalence rate is determined by a procedure established by the law in government-owned laboratories.

Demand for HTPs experienced fast growth rates in the most relevant market where they have been introduced. In Japan, currently the world largest market for HTPs, HTP market share increased from 6.5% in 2016 to 32.5% in 2019. In Italy, market share increased from 0.7% in 2017 to 8.5% in 2020, and in the same years, the average constant rate of growth has been 128%. As a result, one may conjecture that HTPs are likely going to represent a fundamental component of the demand for tobacco products in the next decade, as a result of evolving habits of consumption in most of the countries where they are going to be marketed. A deep understanding of how demand for e-cigs and, especially, for HTPs is intertwined with pre-existing demand for combustible cigarettes is therefore crucial in order to define effective policy (possibly price-related) to reduce demand in accordance with WHO's guidelines.

Increasing demand for HTPs may have had an impact on FMC demand as it can be perceived as a substitute good. In fact, some tobacco industry-funded studies claimed that the formation of and exposure to harmful and potentially harmful constituents is significantly reduced for HTPs relative to standard cigarettes (WHO, 2018). Such claims, not supported by the WHO and national regulators such as US FDA, allegedly fueled demand on a lower-risk perception basis.

Substitutability apparently affects the effectiveness of the channel of transmission of price-related policy impulses on demand. In particular, if FMC and other tobacco products are perceived as substitute, then asymmetric price-related tobacco-control policies (encompassing all tobacco-related categories, including HTPs) may be less effective because of the different relative price between HTP and FMC that such policies may induce.

If a relatively low excise burden on HTPs induces a substitution in consumption between FMC and HTPs, the subsequent decrease in excise revenues in the short run may not be compensated by future benefits due to lower demand for FMC. In fact, potential benefits from switching demand from combustible cigarettes to HTPs are extremely uncertain, and even industry-funded studies failed to provide evidence of modified (not to mention reduced) risk for human health, in both the short and long run. Moreover, lower relative prices of HTPs may determine additional negative externalities for public health deriving from inducing more people to start smoking, which may lead to a potential future start in consuming combustible cigarettes and to induce less people to quit, thus undermining all policies aimed at curbing smoking.

This article investigates whether the volume dynamics of a specific class of products, namely HTPs, exhibits a structural relationship with demand for FMC as a result of substitutability between the two types of products. The theoretical framework is represented by the Marshallian demand for FMC and HTPs. We address the issue of the interdependencies between demand for FMC and HTPs by studying the Italian market. As mentioned above, Italy represents the third most developed market for HTPs in the world and first in the EU as such products have been marketed there for longer than in other countries. The Italian experience is also of interest because it has recently implemented an asymmetric excise policy, reducing the excise burden on HTPs from 50 to 25% of the burden on combustible cigarettes marketed at the weighted average price and has recently programmed a gradual increase to 40% in 2023. Moreover, as shown below, the decade-long decline in demand for combustible cigarettes may have accelerated while HTPs gained significant shares of the market.

The structural interdependence between such demands is analyzed through a cointegration analysis involving also exogenous variables such as real prices and per-capita gross domestic product (GDP) as a proxy for personal income. This approach is motivated by the relative novelty of HTP products that can induce consumption based on motivations other than price. For example, Chen *et al.* (2011) examine the case of cross-elasticity between complementary goods and find that taxing the betel market affect consumption of cigarettes in Taiwan. We find evidence of a cointegration between demand for FMC and HTPs, conditional on price and per-capita GDP. We also find that increase in demand for HTPs prompts permanent decrease in demand for FMC.

The remainder of the article is structured as follows: Section 2 analyses the relevant available data, Section 3 illustrates the econometric model and estimations and Section 4 discusses and concludes. The statistical details from the econometric analysis are provided in Appendix.

2. Materials and methods

Data available for FMC and HTPs are offtake monthly volumes and product-level prices extracted, respectively, from Logista and Nielsen databases [5]. Per-capita gross domestic product (in both purchasing power parity terms - PPP - and volume) and consumption price index (all items) are retrieved by OECD statistical database. The available time series range from 2010m1 to 2020m12 as for FMC and from 2017m1 to 2021m7 as for HTPs, and the logarithm of all variables has used for estimation purposes. In appendix A1, we provide evidence that FMC demand was hit by a structural break as of the introduction of HTP. Such a break motivates a broader estimation approach based on cointegration.

A direct approach for testing for substitutability would be to measure the sensitivity of demand of FMC to the relative HTP price. That would require the estimation of the empirical counterpart of a standard Marshallian demand, whose arguments, other than HTP price, are FMC's own price relative to other goods and income level. Unfortunately, a direct approach may not be the most appropriate to measure substitutability between such types of products. In fact, price may not be the only factor affecting a consumer's choice between consumption of FMC and HTP. A major rationale for consumers demanding HTP may be the individual perception of lower risk, which may arise as a consequence of the recognition by the FDA of modified exposure to a specific type of HTP (see El-Toukhy *et al.* 2018 and Popova *et al.* 2018 for the impact of claims of lower exposure on risk perception). As a result, substitutability may be better modeled by an analysis involving quantities rather than price, thus encompassing all potential factors affecting the degree of substitutability other than prices.

Moreover, a vector error correction (VEC) estimation including price among the endogenous variables, resulted in non-significant coefficients with respect to other variables and the cointegration equation. Therefore, FMC price has been included in the set of unmodelled variables.

The model used to fit data is the following vector error-correction model (ECM) with unmodelled variables as follows:

$$\begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} = \begin{bmatrix} \alpha \\ \alpha_x \end{bmatrix} \beta \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} \Gamma_1 & U_1 \\ 0 & \Gamma_1^x \end{bmatrix} \begin{bmatrix} \Delta y_{t-1} \\ \Delta x_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \Gamma_{p-1} & U_{p-1} \\ 0 & \Gamma_{\mathrm{p}-1}^x \end{bmatrix} \begin{bmatrix} \Delta y_{t-p+1} \\ \Delta x_{t-p+1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix} \tag{1}$$

where y_t is a 2×1 vector of endogenous variables, namely natural logarithm of FMC volume (ARIMA X-12 adjusted) and natural logarithm of equivalent HTP volume at month t, x_t is a 2×1 vector of unmodelled (weakly exogenous) variables such as log of FMC average price and per capita Seasonally-adjusted (SA) real GDP. As a precondition for implementing the Johansen procedure, all the variables in y_t and x_t have been tested for their order of integration. All variables resulted to be the integrated of order 1 by means of Generalized Least Squares (GLS) and augmented Dickey-Fuller tests, conducted by identification of optimal lags through Akaike and Schwartz information criteria, as well as KPSS tests for stationarity. Further details of the procedure for determining the order of integration are in Appendix.

In our estimations, we will restrict $\alpha^x = 0$ and $\Gamma^x_{\mathrm{p}-1} = 0, \forall p > 0$ such that exogenous variables are restricted to affect demand only through the cointegration relationship, and no feedback is allowed on their process. Indeed, no economic reason would support the dependence of changes in y_t due to changes in x_t other than though the cointegration equation.

The loading vector of alpha elements represents the pace at which changes in the endogenous variables occur in response to changes in the cointegration equation $\beta'(y_{t-1}, x_{t-1})'$. Matrix β' represents the long-run interdependence between variables, both endogenous and exogenous.

3. Results

Table 1 shows estimation of the beta and of the alpha vectors in Equation (1). It can be observed that normalized coefficients of the cointegration equation (i.e. elements in β) have the expected signs. Price has a positive sign, implying a negative adjustment in FMC and HTP. Per capita GDP appears with a negative sign, thus affecting FMC demand positively.

To test the hypothesis of HTP demand affecting the Marshallian long-run equilibrium relationship of FMC demand with price and income, we tested restrictions for estimated parameters being individually or jointly equal to zero by means of likelihood ratio tests. Likelihood-ratio (LR) test results are shown in Table 9 (in Appendix). It can be observed that the hypothesis that the coefficient attached to HTP and GDP in the cointegration equation is zero is rejected in the baseline, unrestricted constant, model for all the considered lags-orders. The price coefficient is statistically significant only at 10% confidence level in the unrestricted constant VEC(4). Such a result is quite surprising, as price is generally a key element of individual choices. Nevertheless, results from the ADL models provided in the preliminary analysis support the view that the structural relationship between volume and price has been affected by a structural break (possibly because of the ongoing market penetration of HTPs). Therefore, such a relationship is plausibly evolving along with

		Unrestricted constant		Restricted trend	
		Lags order: 1	Lags order: 4	Lags order: 1	Lags order: 4
Cointegrating vector (β)	FMC (log, SA)	1	1	1	1
		0	0	0	0
	HTPs (log)	0.036	0.030	0.033	0.025
		(0.011109)	(0.0080766)	(0.02118)	(0.014278)
	FMC real price (log)	0.097	0.564	0.027	0.450
		(0.4896)	(0.34595)	(0.73367)	(0.43655)
	GDP per capita (log)	−0.383	−0.272	−0.381	−0.266
		(0.10919)	(0.072396)	(0.11068)	(0.074075)
	Linear trend			0.000	0.001
				(0.0022818)	(0.0013949)
Adjustment vector (α)	FMC (log, SA)	−1.3525	−1.9816	−1.3555	−2.0146
	HTPs (log)	−0.65539	−2.1009	−0.6394	−2.0161

Source(s): Authors' work

Table 1. Estimation results and standard errors in parentheses

preferences, thus suggesting that the sample at hand describers a transition towards a long-run equilibrium that yet has to consolidate.

Table 1 also reports estimated values of the adjustment vector, i.e. the connection between the long-run cointegrated relationship and short-run changes of the vector y_t. The short-run estimations represent the impact on the differenced equations from a perturbation of the cointegration equation (i.e. a deviation from the equilibrium values). It can be observed that, in all model specifications, changes in FMC demand are strongly affected by the dynamics of the cointegration equation. Likelihood-ratio test reported in the lower portion of Table 9 (in Appendix) provide evidence that such coefficients are significantly different from zero. The LR test on adjustment coefficients for the HTP equation only reject the null hypothesis for VEC(4) specifications, as the higher order of lags captures specific dynamics that otherwise are forcedly represented by the long-run equation only. In fact, it can be observed that the HTP coefficient in the cointegration equation has smaller magnitude in the VEC(4) than in VEC(1), despite rejection of the null hypothesis through LR test happens with a smaller p value.

Hence, evidence of dependence between FMC and HTPs arises both in the long and short run. Monthly changes in FMC and HTP demands are jointly driven by Marshallian factors such as price and income and are also intertwined because of the long-run equilibrium relationship.

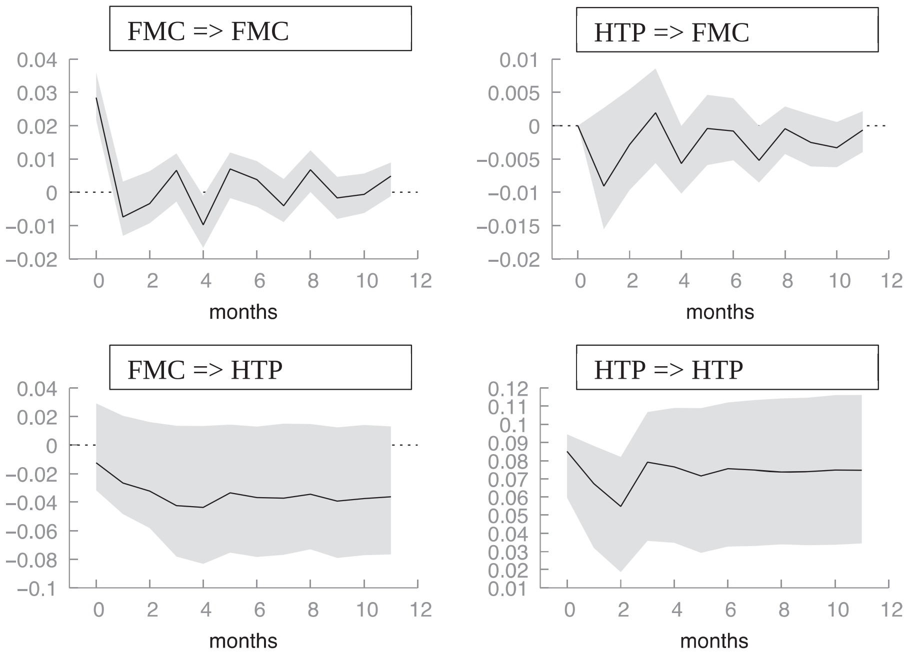
Tests conducted on residuals do not reveal any particular issue in any of the specifications. In particular, Table 10 (in Appendix) provides the Doornik and Hansen (1994) statistics and related p-values in order to test the joint normality of residuals. The null hypothesis of joint normal distribution originating the residuals is not rejected in any of the specification, with VEC(4) models determining higher p-values.

Tables 11 and 12 in Appendix report the Rao F-tests for residual autocorrelation at any lag between 1 and 12. The null hypotheses are not rejected at a 5% level of confidence. Residuals of VEC(1) models exhibit some autocorrelation at fifth lag (the null hypothesis rejected with a 10% confidence level). Nevertheless, additional lags in VEC(4) specifications are enough to account for such autocorrelation.

Tables 13 and 14 (in Appendix) report Lagrange multiplier test statistics (Lütkepohl, 2005) and related p-values to check for conditional heteroscedasticity of residuals. The null hypothesis of absence of conditional heteroscedasticity cannot be rejected at any lags in any of the specifications.

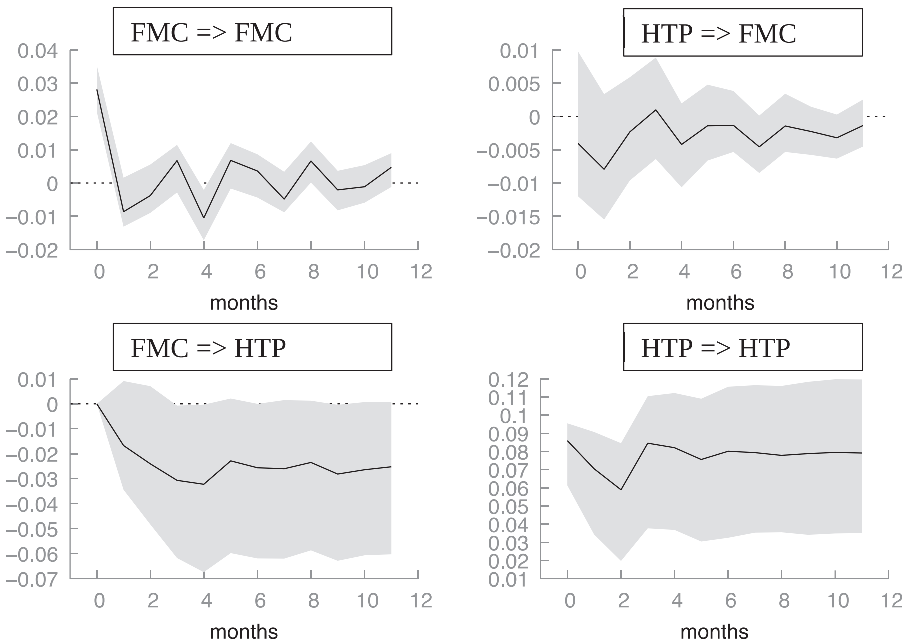
Impulse analysis offers additional insights about the structural relationship between HTP and FMC demands. Figures 1 and 2 depict the orthogonalized impulse responses to shocks to endogenous variables of the VEC(4) model in both possible orderings. Only IRFs from the VEC with unrestricted constant are provided, as the restricted trend specifications do not result in substantially different outcomes. As far as both VEC(1) and VEC(4) specifications are concerned, it can be observed that the shocks ordering does not affect qualitatively the impact. In particular, as shown in the left part of Figures 1 and 2 (and Figures 7 and 8 in Appendix), a shock on FMC demand leads to a persistently negative impact on HTP demand, whereas the impact on FMC itself is temporary as the IRF tends to quickly revert to zero. The impact of a shock on HTP demand is persistently negative both in VEC(1) and in VEC(4). Nevertheless, in VEC(1), if HTPs are positioned higher in the decomposition of the shock matrix as in Figure 7 in Appendix, the initial impact on FMC is slightly positive. Despite such positive initial impact, the shock turns quickly negative and so remains persistently such that the cumulated result is negative. The analysis of orthogonalized IRFs is therefore supporting the hypothesis of a negative relationship between FMC and HTPs also in the short run.

The analysis of forecast error variance decomposition offers additional support in favor of a significant, albeit non predominant, influence of HTP on FMC. Table 2 provides the percentage of FMC forecast error variability that is attributable to the original shock. Only



Source(s): Authors' work

Figure 1. VEC(4) unrestricted constant, IRF (recursive order: FMC – HTPs)



Source(s): Authors' work

Figure 2. VEC(4) unrestricted constant, IRF (recursive order HTPs – FMC)

values from unrestricted constant specifications are reported as the inclusion of a restricted trend does not alter substantially the outcomes.

It can be observed that 24 months after a shock on FMC, according to the VEC(1) model, 75.6% of forecast error variability is attributable to the FMC shock as the remainder (24.4%) is attributable to the variability of HTP demand. Under the alternative recursive order, the portion of the error variance attributable to the original shock on FMC after 24 months is 77.9. According to VEC(4) estimates, such proportion is 84.7% under both recursive orderings. Therefore, the interaction between FMC and HTP demands has an impact on how shocks are absorbed by consumers as the reaction of HTP demand after a shock on FMC accounts for FMC error variance in a proportion ranging from 24.4% to 15.3%. As far as shocks on HTPs are concerned, according to VEC(1) the FMC error variance attributable to such shocks is quite small even after 24 months, ranging from 0.1 to 2% depending on the recursive ordering. According to VEC(4), such proportion is 9.5% under both recursive orderings and occurs mostly in the immediate aftermath of the shock.

It arises that shocks on HTP demand affect FMC dynamics relatively less than interactions with HTP aftershocks on FMC itself. On the one side, this result suggests that exogenous shocks on FMC (e.g. price increases) may induce consumers to possibly partially switch to HTP, thus affecting further negatively FMC demand. On the other hand, exogenous shocks on HTP account to up to almost 10% of FMC dynamics after 24 months. Despite relatively lower, such a proportion is not negligible. It implies that policies affecting HTP demand may have a significant impact on FMC demand. Together with the overall negative cumulative effect of HTP shocks on FMC demand, this should induce caution in implementing asymmetric policies. Too restrictive policies on HTP may lead to an increase in FMC demand, whereas excessively permissive regimes may result in higher consumption of HTP with nevertheless relatively small impact on FMC consumption.

4. Discussion

Results emerging from the analysis carried out in the previous section are twofold. On the one hand, it is detected some evidence of a long-term structural relationship between HTPs and FMC, together with other, theoretically supported arguments such as FMC price in real terms and available income (proxied by per-capita GDP). The relationship is sufficiently strong to constitute a cointegration, therefore helping the definition of an augmented demand curve of FMC also considering the substitution with HTP. Such a substitution is not (exclusively) price-based and can be motivated by cultural evolutions and a different kind of health awareness. We provide evidence that such relationship exists and may have had an impact on the relationship between price and FMC demand. This element is of crucial relevance in determining tax-based policies aimed at curbing smoke. It is not clear to what extent price

	Ordering	Shock on	6 months	12 months	24 months
VEC(1)	FMC-HTP	FMC	90.4	84.9	75.6
		HTP	1.9	2.0	2.0
	HTP-FMC	FMC	93.6	87.7	77.9
		HTP	0.4	0.2	0.1
VEC(4)	FMC-HTP	FMC	91.1	89.0	84.7
		HTP	8.7	9.2	9.5
	HTP-FMC	FMC	91.1	89.0	84.7
		HTP	8.7	9.2	9.5

Source(s): Authors' work

Table 2. FMC forecast error variance decomposition (FEVD) VEC(1) and VEC(4) unrestricted constant (percentage points)

elasticity of demand is affected by the emerging relationship with FMC and this kind of analysis goes beyond the scope of the present article. Nevertheless, evidence suggests that the structural relationship between price and demand is still evolving; therefore, price is becoming statistically less significant with respect to other argument in the demand function, once the dynamics of HTP is taken into account. Nevertheless, because of the economic theory and the analysis of market shocks such as the introduction of HTPs, it is legit to conjecture that the available sample is too short to capture the equilibrium data-generating process, as preferences are evolving to encompass new substitute products that were previously unavailable. This is precisely the shortcoming for using relatively short time series in long-run analyses like cointegration and ECM [6]. Therefore, in order to underpin our results, we estimated an additional autoregressive distributed lag (ADL) model (ADL), which is less sensitive to small sample issues than the Johansen procedure [7]. By means of this additional estimation, we detected the existence of a level relationship between consumption of FMC and HTP by performing a Pesaran *et al.*'s (2001) bounds test. Therefore, we may conjecture that a long-run relationship actually exists between FMC and HTP because the impact of the introduction of the latter, as found in the preliminary analyses as well as in the ADL robustness check, is likely to be permanent as it affects consumption habits of new consumers although understanding the full extent of such a substitution may require additional inquiry as new data become available.

In order to maximize the effectiveness of tax-based policies to curb smoking, the policymaker should consider the potential substitution effects existing with other toxic and addictive products such as HTP and therefore implement similar discouraging policies involving HTP as well. In particular, regulation should not be excessively mild and tax burden should not be excessively low with respect to FMC. In fact, the effectiveness of policies addressing consumption on FMC may be offset by increasing consumption of HTP, whose consequences on human health are still consolidating and no consensus is reached yet.

On the other hand, the quantitative results emphasize a trade-off arising for regulation, involving social benefits from lower consumption of FMC that may be significantly smaller in presence of positive impulses on HTP coming, for instance, from the implementation of a relatively milder regulation, at the cost of higher overall consumption of HTPs. As HTPs are addictive and require the inhalation of toxic chemicals, consumption determines strong negative externalities that must be compensated through an adequate excise revenue. In particular, it is worth to remark that shocks on FMC like price increases (possibly derived from excise increases) are significantly absorbed by consumers who switch (possibly partially) to HTPs, thus reducing the effectiveness of the excise as a policy instrument aimed at curbing consumption.

5. Conclusions

Therefore, a trade-off arises in terms of regulation. The benefits from reducing FMC consumption may be relatively small in the presence of shocks on HTPs, at the cost of higher overall consumption of HTP, an addictive and toxic product with strong negative externalities. On the other hand, negative shocks on FMC are largely absorbed by consumers who switch (possibly partially) to HTPs, thus reducing the effectiveness of policy instruments aimed at curbing consumption of tobacco products addressed to FMC only. The existence of such trade-off should induce a high level of caution in defining policies to curb smoking of both HTP and FMC. In such a framework, symmetric policies arise as a neutral approach in terms of effects on consumers' decisions, thus neutralizing potential additional negative effects on public health deriving from implicit subsidization of products other than FMC and allowing to maximize government revenues, which are necessary counterparties to negative externalities that arise with smoking, HTP and FMC.

The existence of such trade-off, together with the long-run structural relationship, should induce the policymaker to implement policies that are as far as possible symmetric. In fact, shocks on HTP accounts for almost 10% of the forecast-error variance of the FMC equation. A high level of caution in defining policies to curb smoking, both of HTP and FMC, is necessary to assess the potential impact of asymmetric policies. Inducing (or indirectly subsidizing) consumption switching to HTPs, as in the case of a low relative excise with respect to FMC or in presence of a permissive regulation allowing to smoke HTPs indoor, may have unintended negative consequences on public health. The "reverse" causal relationship between HTPs and FMC, the former affecting the latter, should also be accounted for as a basis for broad policies against smoking.

Notes

1. Law n. 165/1962.
2. Law n. 584/1975.
3. Order of the Ministry of Health 2/04/2013.
4. According to Ciccarelli *et al.* (2018), cigarette consumption is generally insensitive to variations in the price of other tobacco products such as cigars, fine-cut and snuff. For instance, they provide evidence that cigars have been a strong complement of cigarettes in the more recent period of their sample whereas the opposite does not hold.
5. Logista is the monopolistic distributor in Italy on behalf of the Italian Government; therefore, it is an official data originator in terms of both sell-in and offtake volumes. Nielsen is a world-class market data provider.
6. The asymptotic distribution of the trace test in the Johansen procedure may be not well approximated by the values derived in Johansen (1996) if the sample is too small. In particular, as found in Jacobson (1995), the trace test values may be undersized, leading to a bias towards the detection of cointegration. An alternative approach with a small sample, also useful as a robustness check, as pointed out in Philips (2017) is relying on autoregressive distributed lags models.
7. See for instance Pesaran and Shin (1999). The details of the autoregressive distributed lag model are reported in Appendix A.1.2.1.

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Appendix

The supplementary material for this article can be found online.

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