The effect of productivity and preference shocks on differentiated-consumption-goods movements*

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Abstract

Moving inside a general equilibrium framework, this paper investigates the relevance of preference and technology shocks on the dynamics of different consumption goods. Analyzing the time series of the final consumption expenditure of the Italian households, it emerges that relative-price movements, which reflect relative-productivity changes, explain a small part of relative-quantity dynamics. It follows that changes in relative preferences between consumption goods are crucial to understand the evolution of the composition of the aggregate consumption. Furthermore, we evaluate two assumptions that often characterize general equilibrium models and support our empirical strategy: i) constant elasticity of substitution between consumption goods; ii) prices do not depend on preferences.

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1 Introduction

This paper investigates the influence of idiosyncratic preference and technology shifts on the relative dynamics of different consumption goods. Indeed, the role and relevance of sectoral productivity shocks on the whole economy have been widely studied. Among the many, Horvath (2000) shows that idiosyncratic technology shocks are able to generate co-movements among economic sectors through the input-output channel. Productivity shocks in sectors whose output is used in most of economic sectors influence in the same direction the cost of production in almost the whole economy. Analogously, Ngai and Samaniego (2009) use the input-output relationships and the difference between value-added and gross output to emphasize that the role of investment-specific technical change is generally underestimated. Indeed, the authors show that variations in the price of gross output of each sector are not due to only changes in the own productivity but are influenced by the variations occurred in the other sectors, concluding that investment-specific technical change accounts for between 93% and 96% of post-war US growth. Referring to consumption goods, Ngai and Pissarides (2007) disregard the role of preference shifts to show that employment should move away from sectors characterized by lower TFP dynamics. It is worth noticing that in this field of literature it is generally assumed that relative TFP dynamics determine relative price dynamics and, consequently, relative quantity dynamics.

On the other hand, there is a field of literature showing that preference shifts may have a significant impact on economy dynamics. For example, in a one-sector theoretical framework, Hall (1997) backs up that only preference shifts can explain the atemporal choice between consumption and leisure. Scanlon (2012) focuses on a multi-sector model to explain the almost stable path of labor hours in developed economies. The author distinguishes between product groups (types of goods characterized by low elasticity of substitution between one and another) and brands (that represent different levels of quality inside a product group and are characterized by high elasticity of substitution between one and another). Including the dynamics of both product groups and brands, Scanlon shows that it is possible to formalize a general equilibrium model characterized by balanced growth path and stable labor hours. A perspective more focused on the asymmetries among business sectors is proposed by Phelan and Trejos (2000). The authors insert asymmetry and relative-preference shifts in a framework with labor-market frictions to show that changes in demand composition can generate aggregate downturns. The authors also provide an empirical application suggesting that the early '90s recession in the US economy could be explained by the American government decision to reduce the purchase of military goods. In the same line, Addessi and Busato (2010, 2011) show that, under a wide range of preference structures, relative-preference shocks can induce co-movement (both recessive and expansive) among economic sectors in terms of consumption, employment, output, and investment also in frameworks with no input-output relationship or market friction.

Starting from some of the assumptions that characterize both sides of the cited literature, this paper uses the optimality conditions that generally characterize macroeconomic models with differentiated consumption goods to identify in which measure idiosyncratic productivity and preference shocks explain the dynamics of relative consumption quantities. Analyzing the time series of the final consumption expenditure of the Italian households at COICOP 2 digits, we find that relative-price movements, which reflect relative-productivity changes, explain a small part of relative-quantity dynamics. It follows, in accordance to the theoretical model, that changes in relative preferences among consumption goods are crucial to understand the evolution of the composition of the aggregate consumption. Since movements in consumption sectors may drive movements in intermediate-goods and investment-goods sector, we consider these results a first step that should stimulate further research on the influence of preference shifts on the composition and dynamics of the entire economy.

These results rely on some theoretical assumptions that often characterize macro models. Specifically, we verify how robust the assumptions of constant elasticity of substitution between consumption goods and no relationship between prices and preferences are. Using Hausman tests we get that the assumption that preferences do not affect prices cannot be rejected and, consequently, the assumption of perfect competition on the supply-side can be preserved. Moreover, normalizing the data for different consumption sectors we get different estimates of the constant elasticity of substitution that most of the times are not significantly different each one from another.

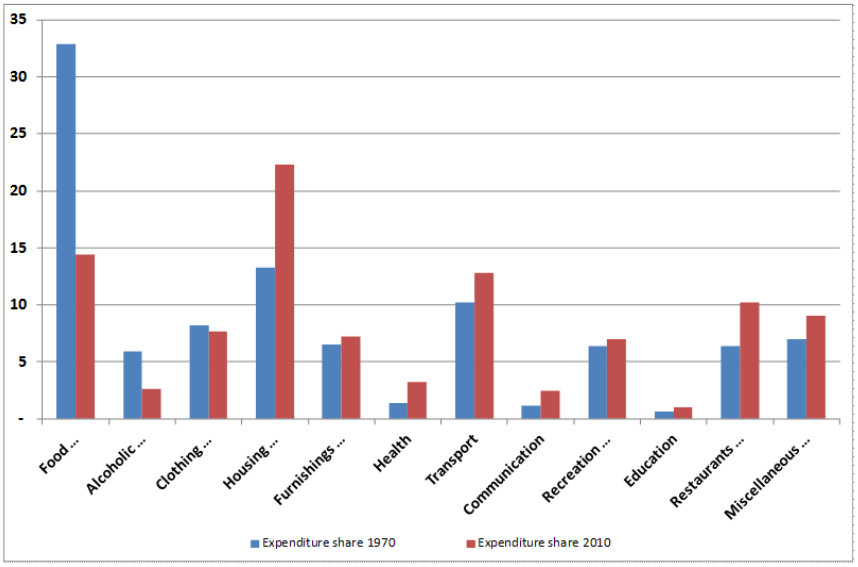
The paper is structured as follows. Section 2 presents some preliminary evidence concerning the evolution of the composition of the Italian aggregate consumption and the behavior of relative prices and quantities. Section 3 sketches the theoretical assumptions and optimality conditions that support the empirical analysis. Furthermore, it presents the data manipulation and the estimation procedure adopted. Section 4 discusses the empirical results and Section 5 draws conclusions and future lines of research.

2 Preliminary evidence

In our empirical analysis we use the time series of the final consumption expenditure of Italian households by purpose (COICOP 2 digits) as published by ISTAT (the Italian Institute of Statistics). Data have annual frequency and range from 1970 to 2010. Figure 1 reports the expenditure share of each type of consumption good at the beginning and the end of the time period. As in most of the advanced economies, the relevance of food and non-alcoholic beverage (COICOP 01) has fallen down. Moreover, while the remaining types of consumption goods have experienced absolute variations lower than 4 percent points, housing, water, electricity, gas and other fuels (COICOP 04) has gained 9 percent points. All in all, especially due to the fall of the weight of food and non-alcoholic beverage, the expenditure shares have changed significantly, indicating that a Cobb-Douglas formalization of consumption preferences could be not appropriate, since it would imply constant expenditure shares.

Since we are interested in the role of different types of idiosyncratic shocks, it's important to observe price and quantity dynamics of each good with respect to the dynamics of the other goods. In this introductory section we use as benchmark the growth rates of furnishings, household equipment and routine household maintenance (COICOP 05). That implies that the data reported in Figure 2 and Table 1 measure the relative dynamics of each type of good with respect to that of COICOP 05.

FIGURE 1. EXPENDITURE SHARES



For each type of consumption good, Figure 2 reports the relative quantity and price dynamics, and Table 1 reports the average and standard deviation of the annual relative growth rate and the correlation between quantity and price growth rates. It emerges that price dynamics seem to be smoother than quantity dynamics and, indeed, the standard deviations of the latter are generally higher than the standard deviations of the former, with exception of two types of goods (COICOP 02 and 04). Furthermore, quantity dynamics are negatively related to price dynamics, even if with marked differences. For example, looking at the graph of the dynamics of communication sector (COICOP 08), it emerges at a glance a strongly negative relationships between quantity and price series, but this is not clear if we look at education sector (COICOP 10). Table 1 reports that price and quantity time series are negatively correlated most of the times even if in just four cases the correlation coefficient is statistical significant at 5% or less.

Figure 2. Relative Quantities and Prices Dynamics - Relative annual growth rate with respect to COICOP 05

Table 1. Relative Quantities and Prices Dynamics - Relative annual growth rate with respect to COICOP 05

COICOP	quantity		price		corr(price,quantity)
	mean	s.d.	mean	s.d.	
01	-1.9	3.7	-0.6	2.3	-0.14
02	-2.5	3.7	0.1	4.9	0.01
03	-0.41	2.1	-0.1	2.0	-0.45[a]
04	-0.5	3.7	1.5	3.9	-0.15
06	3.0	4.4	-1.1	3.8	-0.15
07	-0.1	4.1	0.5	2.8	-0.42[a]
08	3.9	9.1	-1.8	5.2	-0.55[a]
09	0.6	3.1	-0.7	2.2	-0.20
10	0.2	5.5	0.7	3.9	0.07
11	-0.3	4.2	1.2	2.0	-0.28
12	-0.2	4.4	0.7	3.3	-0.40[a]

[a] The correlation is significant at 5% or less. Data have been calculated using COICOP 05 as benchmark.

3 Empirical analysis

3.1 Theoretical background

Our analysis is based on the static optimality conditions that rule the households' choice among differentiated consumption goods. For this reason, we present just the elements affecting this choice, leaving out the other elements that characterize a standard general equilibrium model, since they would not provide useful insights for our analysis. Anyway, our results are fully consistent with the standard formalization of a dynamic general equilibrium framework.

Let us assume that households are characterized by an utility function concave in the aggregate consumption bundle $C(\cdot)$ that has the constant elasticity of substitution (CES) form

$$C = \left(\int_0^1 \alpha_j^{\frac{1}{\theta}} C_j^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}},$$

where C_j and α_j denotes, respectively, real consumption of, and preference for, good j, and θ is the elasticity of substitution among consumption goods.[1] The optimality requires

$$c_{ji} = \alpha_{ji} p_{ji}^{-\theta}, \forall j \neq i, \tag{1}$$

where c_{ji}, p_{ji}, and α_{ji} are, respectively, the ratio between good j and good i in terms of consumption, price, and preference. Eq. (1) is quite intuitive: the consumption of good j with respect to the consumption of good i is increasing in the relative preference for good j and is decreasing in its relative price. Expressing Eq. (1) in terms of growth rates (denoted by the tilde) we get

$$\widetilde{c}_{ji} = \widetilde{\alpha}_{ji} - \theta \widetilde{p}_{ji}, \forall j \neq i. \tag{2}$$

As in large part of the literature cited in the Introduction, the supply side is supposed to be characterized by constant returns to scale and perfect competition. By this way, relative prices are determined by relative production costs, whose variations are originated by idiosyncratic

[1] The time indicator has been omitted since the following relationships, reported both in levels and time variations, are supposed to be effective in each moment.

productivity shocks.[2] In this framework, where firms are price-takers, the elasticity of substitution between consumption goods can assume values lower than 1. Furthermore, this theoretical assumption supports an estimation procedure of Eq. (1) in which the unobserved part, the time-variation of relative preferences, is not correlated to the observed part, the time-variation of relative prices.

3.2 Empirical strategy

We have just seen that the theoretical framework provides clear indications concerning the behavior of real consumption and price expressed in relative terms between a sector and another. Starting from the data referred to the final consumption of the Italian household, we built 12 different dataset (each one containing 11 time series), each time using a different consumption good as benchmark to calculate the relative growth rates in terms of quantity and price. The number which identifies each dataset reflects the COICOP 2 digits classification of the type of consumption good that has been used as benchmark (for example, dataset 3 is built subtracting to the dynamics of each good the dynamics of clothing and footwear sector, COICOP 03). The assumption of a constant elasticity of substitution among consumption goods, which characterized the formalization of most of the macroeconomic models, is clearly a simplification, but repeating the estimation procedure using different consumption goods as benchmark good is a way to evaluate how much this assumption is strong when the reference is to the COICOP 2 digits classification. Moreover, according to our perspective, preferences are subjected to idiosyncratic shocks and do not affect price dynamics. Consequently, a random effect regression of the growth rate of relative quantities on the growth rate of relative prices is fully consistent with our theoretical framework. Anyway, each time, we run Hausman tests to validate the random effect estimation procedure and verify whether and in which measure data support the theoretical assumptions.

Finally, we will repeat the estimation procedure working on filtered data. We will assume that relative preference and productivity growth rates are characterized by stochastic trends. After filtering the data applying the Hodrick-Prescott filter we will repeat the analysis on the cyclical

[2] See Ngai and Pissarides (2007).

component of the time series.

4 Results

4.1 Main Results

The estimation results are reported in Table 2. The first two columns show the punctual estimates and the 95% confidence intervals of the elasticity of substitution θ. The value of $\widehat{\theta}$ is always statistical significant at less than 1% level, with the exception of case 10 in which it is significant at 5%. As expected relative price dynamics affect negatively relative volume dynamics (the effect is given by $-\theta$). It emerges that the punctual estimates depend on the consumption good used as benchmark to build the relative growth rates. Anyway, in ten out of twelve cases, the estimated values range between 0.28 and 0.52 and most of the time are not statistically different one with another. The estimate obtained in case 10 is particularly low, while the opposite occurs in case 8 where the estimated elasticity of substitution is not significantly different from unity.

Concerning the independence of prices from preferences, we ran different Hausman tests in which the null hypothesis is that fixed effect and random effect estimates are not significantly different one each other. If the null hypothesis cannot be rejected it implies that the unobserved relative preference dynamics can be considered uncorrelated with the observed relative price dynamics. In Table 2 we report the *p-values* of three types of Hausman tests for each regression. They differ according to the covariance matrix used to run the test. In column *HTa*, *HTb*, and *HTc* the covariance matrix is obtained, respectively, from the estimated difference, the random effect estimation, and the fixed effect estimation. Altogether, the null hypothesis can be rejected with 1% confidence level in just three out of thirty-six tests, and in other three cases at 5%.

Furthermore, it has been tested whether the regression residuals follow a white noise process. It implies to run eleven tests (one for each consumption sector) for each of the twelve dataset, that is 132 tests. Results indicate that the white noise hypothesis can be rejected at 1% confidence just in 20 cases.

Finally, it has to be noticed that relative-price dynamics explain a small part of relative-quantity dynamics. The R^2s reported in the last column of Table 2 show that relative-price dynamics never explain above one third of relative-quantity dynamics.[3] That implies that the unobserved part, that according to the theoretical model represents relative-preference dynamics, is of primary importance for the understanding of relative-quantity dynamics.

TABLE 2. ESTIMATION - HERE

dataset	$\widehat{\theta}$	95% interval	HTa	HTb	HTc	WN 1%	WN 5%	WN 10%	R-sq
1	.42	[.32 .52]	0.008	0.045	0.044	2	2	3	0.15
2	.28	[.20 .36]	0.008	0.068	0.067	3	4	4	0.10
3	.28	[.15 .42]	0.089	0.121	0.121	0	1	2	0.05
4	.28	[.19 .37]	0.004	0.090	0.089	1	3	3	0.09
5	.36	[.24 .48]	0.143	0.171	0.170	0	0	1	0.08
6	.46	[.35 .56]	0.490	0.474	0.474	2	5	6	0.13
7	.44	[.34 .54]	0.206	0.229	0.229	0	2	2	0.15
8	.91	[.79 1.03]	0.447	0.432	0.432	1	1	1	0.33
9	.46	[.34 .57]	0.216	0.234	0.234	4	5	5	0.14
10[a]	.15	[.02 .28]	0.021	0.058	0.057	2	4	7	0.02
11	.52	[.40 .64]	0.211	0.230	0.230	2	3	3	0.15
12	.40	[.31 .48]	0.137	0.191	0.191	1	1	2	0.17

[a] indicates the only case in which the estimated elasticity of substitution is not significant at 1%, but at 5%. Columns HTa, HTb, and HTc report the p-values of the Hausman tests in which the covariance matrix is obtained, respectively, from the estimated difference, the random effect estimation, and the fixed effect estimation. Columns WN 1%, WN 5%, WN 10% report the number of times in which the hypothesis that the sector residuals are white noises can be rejected with, respectively, 1%, 5%, and 10% confidence.

4.2 Extension

Finally, we have assumed that the growth rates follow stochastic trends. Then, we have disentangled the cyclical component applying the Hodrick-Prescott filter and run the same set of

[3] Plots of the observed and predicted series are available upon request.

estimations and tests.[4] Results are reported in Table 3. It is worth noticing that the estimates of the elasticity of substitution have not changed significantly and the highest difference emerges in case 3, moving from .28 to .45 while the estimated coefficient in case 10 becomes non-significantly different from zero. All the Hausman tests largely support random effect estimations. Also the white noise tests, most of the times, do not allow to refuse the null hypothesis of no auto-correlation in the residuals. Finally, as in the previous estimations, price dynamics explain a small part of quantity dynamics, supporting an important role of preference dynamics.

Table 3. Estimation on cyclical component - here

dataset	$\widehat{\theta}$	95% interval	HTa	HTb	HTc	WN 1%	WN 5%	WN 10%	R-sq
1	.53	[.41 .64]	0.996	0.984	0.984	0	0	1	0.19
2	.27	[.15 .39]	0.973	0.883	0.884	0	1	2	0.05
3	.45	[.30 .60]	0.982	0.931	0.932	1	1	2	0.09
4	.33	[.24 .42]	0.980	0.889	0.890	0	1	1	0.13
5	.48	[.33 .63]	0.991	0.964	0.964	1	2	3	0.11
6	.52	[.39 .64]	0.995	0.976	0.976	0	1	2	0.17
7	.34	[.21 .46]	0.974	0.866	0.868	0	0	1	0.08
8	1.05	[.91 1.18]	0.970	0.823	0.825	3	5	6	0.42
9	.40	[.26 .54]	0.983	0.933	0.933	3	5	5	0.09
10[a]	.06	[-.18 .07]	0.970	0.843	0.845	1	1	1	0.002
11	.57	[.43 .72]	0.989	0.957	0.957	0	0	2	0.17
12	.48	[.37 .59]	0.980	0.842	0.845	0	1	3	0.20

[a] indicates the only case in which the estimated elasticity of substitution is not statistically significant, while in the other cases is always significant at 1% level or less. Columns HTa, HTb, and HTc report the p-values of the Hausman tests in which the covariance matrix is obtained, respectively, from the estimated difference, the random effect estimation, and the fixed effect estimation. Columns WN 1%, WN 5%, WN 10% report the number of times in which the hypothesis that the sector residuals are white noises can be rejected with, respectively, 1%, 5%, and 10% confidence.

[4] Since the Hodrick-Prescott filter do not perform well at the tails, we dropped the first and last five observations, reducing our time sereis from 40 to 30 observations.

5 Conclusion and discussion

In this paper, we employed theoretical assumptions that generally characterize baseline versions of dynamic stochastic general equilibrium models to quantify the effect of relative technology and preference shocks on consumption-goods dynamics. We assumed perfect competition on the supply side in order to identify technology dynamics with price dynamics. On the demand side, we assumed a CES utility function with weights representing the relative preference for each consumption good. As expected, we found a negative effect of price dynamics on quantity dynamics but the former explains a small part of the latter. According to the theoretical model, this result should suggest that preference dynamics are more relevant than technology dynamics for the understanding of the evolution of the composition of the aggregate consumption.

Tests have been run to verify if preference dynamics affect price dynamics and if regression residuals can be considered white noise processes. Most of the times, such tests support the theoretical assumptions. Finally, we have elicited the cyclical component from the original time series and we have repeated the same analysis. Results have not changed significantly.

The results of this paper highlight the importance of the analysis of preferences when dealing with a multisector economy and ask for further steps in this direction. At the moment two main directions we consider more urgent. First of all, it would be important to extend the analysis to all the types of goods (not only consumption goods), but in that case it would be important to disentangle the quantities aimed at final consumption and the quantities employed as intermediate or investment goods. The other important step is the introduction of a non-homothetic utility function, whose empirical relevance has be highlighted, among the others, by Herrendorf et al. (2011). By this way, it would be possible to elicit movements related to aggregate dynamics and movements affected by idiosyncratic preference and technology shocks.

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