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Convergence of Public Pharmaceutical Spending in the European Union: Evidence from IMF COFOG Data, 2001–2021

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Abstract

Government expenditure on medical products, appliances and equipment, a functional category in which pharmaceuticals are by far the largest component, is a distinct but rarely examined part of health budgets in the European Union. This study asks whether cross-country differences in this category have narrowed since the early 2000s. It uses general government spending as a share of gross domestic product from the International Monetary Fund's Government Finance Statistics, organised by function of government, for 25 member states over 2001–2021, and tests for sigma-convergence through trend regressions on annual dispersion and for beta-convergence through a cross-section catching-up regression and a fixed-effects panel with crisis dummies. Dispersion declines over the period, with a trend coefficient of −0.0029 ($p = 0.013$) for the standard deviation and −0.0020 ($p < 0.001$) for the coefficient of variation. Initial levels explain 47 per cent of the variation in subsequent growth ($\beta = -0.029$, $p < 0.001$), and the lagged level carries a coefficient of −0.272 ($p < 0.001$) in the panel of 500 country-year observations, an estimate treated as an upper bound on adjustment speed given the small-sample bias of fixed-effects estimators. The financial crisis and the pandemic raised spending temporarily without reversing convergence. Romania grew at about 8.7 per cent per year between 2001 and 2014 and then contracted as the clawback tax of 2009 matured, ending the period below the sample mean. Catching-up in pharmaceutical budgets is real but fragile, and national pricing and reimbursement policy shapes it as much as income does.

Keywords: government health expenditure; medical products; catching-up; panel fixed effects; Romania
JEL Classification: H51; I18; C23

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1. INTRODUCTION

European integration exerts a persistent pull towards similarity in the way member states allocate public money. Convergence has been documented for social protection, for infrastructure investment and, within health, for total expenditure, insurance coverage and population outcomes, with the post-transition economies of Central and Eastern Europe gradually closing the distance to Western European averages (Hitiris & Nixon, 2001; Panopoulou & Pantelidis, 2012; OECD & European

Union, 2024). One component of health spending has nonetheless escaped dedicated convergence analysis: the money governments spend on medical products, appliances and equipment.

In the Classification of the Functions of Government (COFOG), this component is group 07.1. It brings together three classes: pharmaceutical products (07.1.1), other medical products such as dressings, diagnostic kits and consumables (07.1.2), and therapeutic appliances and equipment such as spectacles, hearing aids, prostheses and wheelchairs (07.1.3). In every European country for which a breakdown is available, pharmaceuticals account for the large majority of the group, which is why the category serves throughout this article as a proxy for public pharmaceutical spending, with the caveat that it covers somewhat more than medicines (International Monetary Fund, 2014; Eurostat, 2024b). What the group records is the outlay of general government on these goods when they are provided or reimbursed outside hospital care; medicines dispensed during an inpatient stay are booked under hospital services (07.3) and do not appear here.

The omission matters because this is not a routine administrative line. What the state spends on medical products determines whether patients can obtain the treatments they are prescribed, how the burden is divided between public budgets and households, and what price signals reach the market (WHO Regional Office for Europe, 2023). The variation across the Union is wide. Germany devoted 1.77 per cent of gross domestic product (GDP) to the category in 2021, whereas Denmark and Malta spent about 0.52 per cent. Romania moved from 0.42 per cent in 2001 to a peak of 1.29 per cent in 2014 and then fell back to 0.86 per cent by 2021. Income and demography cannot account for differences of this size; pricing architectures, reimbursement lists, negotiating capacity with industry, generic substitution and the quality of administration all contribute (Vogler et al., 2011; Dylst et al., 2013; European Commission, 2020).

Government Finance Statistics (GFS) compiled by the International Monetary Fund (IMF) and organised by COFOG function make it possible to follow this category for all current member states over two decades. The present study uses that resource to pursue three objectives. The first is descriptive: to map the level and trajectory of public spending on medical products across the Union between 2001 and 2021 and to position each country against the regional trend. The second is inferential: to test formally for sigma-convergence, meaning a decline in cross-country dispersion over time, and for beta-convergence, meaning faster growth in countries that started from lower levels, with panel techniques suited to a short annual series. The third is to ask whether the two major shocks of the period, the financial crisis of 2008–2010 and the pandemic of 2020, disturbed the long-run pattern, and to check the robustness of the results to sample composition and specification.

Romania serves as the anchor case. Its trajectory combines very rapid growth in the first half of the period with a marked reversal after 2014, and this profile raises questions that macroeconomic variables alone cannot answer. The clawback tax introduced in 2009, external reference pricing and the institutional make-up of the Romanian health system are all part of the story, but the data suggest

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that no single instrument explains the whole path (Vladescu et al., 2016; OECD & European Observatory on Health Systems and Policies, 2023).

The remainder of the article is organised as follows. Section 2 reviews the convergence literature, the evidence on health expenditure convergence, the determinants of pharmaceutical spending and the Romanian case. Section 3 describes the data, the sample and the four models estimated. Section 4 presents descriptive results, the convergence tests, the diagnostics and Romania's position within the framework. Section 5 interprets the findings and Section 6 concludes with limitations and directions for further work.

2. LITERATURE REVIEW

2.1 Convergence Concepts and Their Measurement

That poorer economies grow faster than richer ones and gradually close the gap descends from the neoclassical growth model and was turned into an empirical programme by Barro and Sala-i-Martin (1992). Transposed to public finance, the question becomes whether integration and shared policy frameworks have reduced disparities between member states in the amount they allocate to particular functions. Two measurement concepts dominate the literature. Sigma-convergence asks whether the cross-sectional dispersion of an indicator, usually measured by its standard deviation or its coefficient of variation, shrinks over time. Beta-convergence asks whether units that start from a low level subsequently grow faster, which is tested by regressing the growth rate on the logarithm of the initial level and looking for a negative slope. The two are related without being equivalent: beta-convergence is necessary for sigma-convergence but not sufficient, since idiosyncratic shocks can widen dispersion even while catching-up is under way (Barro & Sala-i-Martin, 1992).

Econometric practice in testing beta-convergence has matured considerably since the early cross-section studies. Islam (1995) showed that a panel with country fixed effects captures conditional convergence towards country-specific steady states and typically produces much faster implied adjustment than cross-section regressions do. That acceleration is not entirely a discovery about the world. Nickell (1981) established that the within estimator of a lagged dependent variable is biased downward in short panels, with a bias of order 1/T, and Hauk and Wacziarg (2009) demonstrated with Monte Carlo experiments that the fixed-effects estimator overstates convergence speed substantially in growth regressions with the time dimensions usually available. The implied speed from a fixed-effects regression is therefore an upper bound rather than a point estimate. A different strand, associated with Phillips and Sul (2007), abandons the single-equilibrium assumption and tests for convergence clubs, groups of units that converge among themselves while diverging from other groups. Club testing needs a longer time dimension than the present data provide, but the idea helps in interpreting heterogeneous trajectories.

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2.2 Evidence on Health Expenditure Convergence

Convergence of total health expenditure across developed countries has been examined repeatedly. Hitiris and Nixon (2001) found evidence of convergence in per capita health spending among the then fifteen member states of the Union, and Panopoulou and Pantelidis (2012) documented convergence in both spending and outcomes across the OECD, with results that depend on the period, the sample and the specification. Nghiem and Connelly (2017) confirmed conditional convergence for OECD health expenditure over a longer horizon and identified income and demographic structure as the main drivers of the steady state. The State of Health in the EU cycle reports a gradual narrowing of the spending gap between the newer and older member states in the 2010s, although the gap in per capita terms remains large (OECD & European Union, 2022, 2024).

What this literature has not asked is whether convergence extends below the aggregate to particular functional categories, and pharmaceutical spending is the category where the answer is least obvious. Medicines are more directly exposed to national policy instruments than any other health input: reference pricing, reimbursement lists, clawback taxes and generic promotion all act on this line item with little delay (Vogler et al., 2011). National choices can therefore accelerate or block convergence in ways that the aggregate masks, and a country can converge in total health spending while diverging in its pharmaceutical budget. The present study fills that gap for the Union.

2.3 Determinants of Public Spending on Medical Products

Income is the most obvious determinant of pharmaceutical spending in absolute terms, but the relationship with spending as a share of GDP is far less mechanical, because cost-sharing rules mediate the link between income and public outlay (OECD, 2023). Demography and disease patterns matter over long horizons, yet they explain little of the cross-country variation among member states with broadly similar age structures and chronic disease burdens (European Commission, 2024).

Most of the explanatory power lies in the architecture of pharmaceutical policy. External reference pricing, centralised procurement and negotiation, cost-volume agreements and generic substitution create wide variation in public pharmaceutical spending even between countries that look alike on demographic and epidemiological indicators (Vogler et al., 2011; Dylst et al., 2013). These instruments operate through different channels. Reference pricing constrains unit prices, generic promotion changes the composition of prescriptions and clawback taxes cap aggregate expenditure by transferring fiscal risk to manufacturers. The Union has begun to coordinate some of these levers through joint procurement after the pandemic and the proposed revision of pharmaceutical legislation (Vogler et al., 2021a; European Court of Auditors, 2022; European Commission, 2023), while biosimilar policies have opened a further margin for savings in high-cost segments (Vogler et al., 2021b).

The role of administrative governance receives less attention but is conceptually important. The same pricing rule produces different results depending on whether the implementing body has the

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capacity, transparency and control mechanisms to apply it. Public sector audit and monitoring arrangements are part of that capacity, and the argument made by Vasile and Croitoru (2020) about autonomous administrative structures in resource management applies directly to how pharmaceutical budgets are planned, executed and controlled. Whether governance quality affects pharmaceutical spending specifically is a question this study touches only indirectly, through the country fixed effects.

2.4 Economic Crises and Pharmaceutical Budgets

Any convergence analysis spanning 2001–2021 has to accommodate two exogenous shocks. The financial crisis of 2008–2010 triggered austerity-driven cuts to public health budgets in Southern and Eastern Europe, with documented consequences for access and outcomes (Mladovsky et al., 2012; Karanikolos et al., 2013). Pharmaceutical policy was the first line of response in many countries: Vogler et al. (2011) recorded price cuts, margin reductions, reference price revisions and new taxes on manufacturers in the majority of European systems within two years of the crisis. The pandemic of 2020 was a shock of a different kind: emergency procurement of protective equipment, tests and therapeutic agents raised spending on medical products almost everywhere, within the largest peacetime fiscal expansion in the Union's history (International Monetary Fund, 2023, 2024a). Both episodes are handled here through crisis dummies in the panel specification, so that cyclical effects can be separated from the underlying convergence process.

2.5 The Romanian Case

Romania is a case of high analytical value. Accession in 2007 brought simultaneous pressure for regulatory harmonisation and for closing the expenditure gap with the Union average. Public spending on medical products, expressed in the IMF series used here, rose from 0.42 per cent of GDP in 2001 to 0.88 per cent in 2005 and 1.29 per cent in 2014, roughly a tripling of the ratio within thirteen years.

Two policy interventions shaped what followed. The clawback tax, introduced in 2009 and revised repeatedly thereafter, requires marketing authorisation holders to return to the health insurance fund the part of reimbursed consumption that exceeds a quarterly reference budget. Vogler et al. (2011) listed it among the more unusual European responses to the crisis, and Vladescu et al. (2016) noted that it contained nominal growth while producing side effects on supply and on the availability of low-priced products. External reference pricing against the lowest price in a basket of twelve countries reinforced the downward pressure on unit costs. The decline in spending from 1.29 per cent of GDP in 2014 to 0.86 per cent in 2021 is consistent with the cumulative effect of these instruments in combination with the wider fiscal consolidation of the period, although faster GDP growth also lowered the ratio.

The institutional setting is also distinctive. Pharmaceutical policy is centralised in the Ministry of Health, the National Agency for Medicines and Medical Devices and the National Health Insurance House, an arrangement that gives negotiating power but limits flexibility, and Romania continues to

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record among the highest levels of unmet need for medicines and of catastrophic out-of-pocket spending in the Union (OECD & European Observatory on Health Systems and Policies, 2023; WHO Regional Office for Europe, 2023). These features are what country fixed effects absorb in the panel, and they are why Romania is examined separately in Section 4.6.

3. METHODOLOGY

3.1 Data Source and Definition of the Variable

Throughout the analysis, the dependent variable is general government expenditure under COFOG group 07.1, medical products, appliances and equipment, expressed as a percentage of GDP. The series come from the IMF Government Finance Statistics (International Monetary Fund, 2024b), accessed through the World Bank Data360 platform under indicator code IMF_COFOG_GELM_GF0701 (World Bank, 2024). The general government sector consolidates central government, local administrations and social security funds, the appropriate level for cross-country comparison because it does not depend on whether a country finances medicines through an insurance fund, the state budget or regional authorities.

As a check, the IMF series were compared with the Eurostat dataset gov_10a_exp, which publishes the same COFOG breakdown from national accounts submissions under the European System of Accounts (Eurostat, 2024a). For the large majority of country-years the two sources agree to within rounding; where they differed by more than 0.02 percentage points, typically for early years that were later revised, the IMF value was retained to preserve consistency within the series, and the discrepancy is documented in the replication material. The Eurostat Statistics Explained overview of government expenditure on health was used to confirm that group 07.1 is dominated by pharmaceutical products in the countries that report the three-digit detail (Eurostat, 2024b).

3.2 Sample and Coverage

Coverage extends to all 27 current member states for the 21 years from 2001 to 2021 and is used in that form for the descriptive material in Section 4.1. Two countries are excluded from every dispersion statistic and every regression, so that the convergence tests rest on 25 member states. Poland reports values of 0.05 to 0.06 per cent of GDP for the entire period, an order of magnitude below any comparable system; the pattern reflects the classification of most reimbursed medicines under outpatient services in the Polish submission rather than genuinely negligible spending, and including it would add a large classification artefact to the low end of the distribution. Latvia records 0.0001 per cent in 2001, which makes the logarithm of its initial level and its growth rate over the period analytically meaningless. Neither country is used in Tables 2 to 4.

Two further cases deserve mention because they remain in the sample. The Portuguese series falls from 1.60 per cent of GDP in 2005 to 0.59 per cent in 2010 and 0.38 per cent in 2014, and the

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Bulgarian series falls from 1.32 per cent in 2001 to 0.52 per cent in 2005. Part of the Portuguese decline is real and corresponds to the pharmaceutical measures of the adjustment programme after 2011, but the size and abruptness of both step changes, coinciding with revisions of national accounts submissions in the second half of the 2000s, suggest that some reclassification between COFOG groups 07.1, 07.2 and 07.3 is involved. The two countries are therefore retained in the main estimates and removed in the robustness specification.

Table 1 gives an overview of the level and trajectory for fifteen countries, chosen to span the distribution, at five points in time.

Table 1.
Public expenditure on medical products, appliances and equipment, selected EU member states (% of GDP, general government)

Country	2001	2005	2010	2014	2021
Germany	1.558	1.481	1.601	1.569	1.768
France	1.184	1.273	1.487	1.451	1.496
Luxembourg	1.591	1.671	1.735	1.701	1.673
Greece	1.327	1.733	2.259	1.357	1.553
Austria	1.079	1.101	1.097	1.099	1.212
Croatia	0.986	1.080	1.047	1.187	1.232
Romania	0.417	0.877	1.070	1.289	0.855
Czechia	1.175	1.325	1.032	0.979	0.896
Belgium	0.798	0.850	0.912	0.823	0.800
Hungary	1.328	1.639	1.368	0.967	0.740
Sweden	0.845	0.865	0.800	0.720	0.744
Finland	0.535	0.659	0.662	0.644	0.701
Bulgaria	1.323	0.521	0.484	0.660	0.672
Portugal	1.245	1.601	0.593	0.375	0.646
Denmark	0.678	0.721	0.762	0.595	0.517

Note: COFOG group 07.1. Poland and Latvia are not shown; see Section 3.2.

Source: IMF Government Finance Statistics (COFOG), via World Bank Data360. Author's own calculations.

3.3 Models

Four models are estimated and are referred to by the same labels in the results. Model 1 is the unconditional cross-section beta-convergence regression. Model 2 is the panel fixed-effects specification with crisis dummies. Model 3 replaces the crisis dummies with a full set of year effects. Model 4 re-estimates Model 2 on the reduced sample of 23 countries that excludes Bulgaria and Greece.

Sigma-convergence is assessed before any of these models by computing, for each year from 2001 to 2021, the cross-country standard deviation and coefficient of variation of the spending ratio across the 25 countries, and then regressing each series on a linear time trend by ordinary least squares. A negative and significant trend coefficient indicates declining dispersion. The coefficient of

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variation is reported alongside the standard deviation so that a fall in absolute dispersion is not mistaken for convergence when it merely reflects a lower mean.

Model 1 is the standard catching-up regression in Equation (1):

$$g_i = \alpha + \beta \ln(y_i,2001) + \varepsilon_i \quad (1)$$

where g_i is the annualised log growth rate of the spending ratio of country i between 2001 and 2021, computed as the difference of logarithms divided by twenty, and y_i,2001 is the initial level. A negative and significant β indicates that countries with lower initial levels grew faster. Equation (1) uses one observation per country and therefore 25 observations.

Model 2 exploits the annual panel through Equation (2):

$$\Delta\ln(y_it) = \alpha + \beta_1 \ln(y_i,t-1) + \beta_2 D2009_t + \beta_3 D2020_t + \mu_i + \varepsilon_it \quad (2)$$

where Δln(y_it) is the annual log growth rate, ln(y_i,t−1) is the lagged log level, D2009 is a dummy equal to one in 2009 and 2010, D2020 is a dummy equal to one in 2020, and μ_i are country fixed effects. The panel loses the first year to the lag, so it contains 20 annual observations for each of the 25 countries, or 500 country-years in total. A negative β_1 indicates conditional beta-convergence towards country-specific steady states.

Model 3 is the two-way fixed-effects version in Equation (3):

$$\Delta\ln(y_it) = \alpha + \beta_1 \ln(y_i,t-1) + \mu_i + \lambda_t + \varepsilon_it \quad (3)$$

where λ_t are year effects that absorb every common shock, including the two crises, so that β_1 measures country-specific adjustment net of all common trends. Model 4 repeats Equation (2) without Bulgaria and Greece, the two countries with the largest single-year movements, and yields 460 country-years.

The coefficient β_1 in Equations (2) and (3) is translated into an annual adjustment speed and a half-life through Equation (4):

$$\lambda = -\ln(1 + \beta_1), \quad h = \ln(2) / \lambda \quad (4)$$

where λ is the speed of adjustment and h the number of years needed to close half of the distance to the steady state. The same transformation is applied to Model 1, with the difference that β in Equation (1) is an average over twenty years and the implied speed is obtained by solving (1 − e^(−20λ)) / 20 = −β.

3.4 Estimation and Diagnostics

All panel models are estimated by the within estimator with heteroskedasticity-consistent (HC3) standard errors. The choice between fixed and random effects is guided by the Hausman test. Residuals are examined with the Breusch-Pagan test for heteroskedasticity, the Durbin-Watson statistic for first-order serial correlation, variance inflation factors for collinearity among regressors

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and the Jarque-Bera statistic for normality, and the diagnostic plots are reported for Model 2. Two features of the design condition the interpretation of the panel results. The lagged level in Equations (2) and (3) is, up to a reparameterisation, a lagged dependent variable, so the within estimator is subject to the small-sample bias described by Nickell (1981), which with T = 20 is not negligible and works towards a more negative β_1. In addition, the growth-rate form of the dependent variable and the year-to-year volatility of several series produce heavy-tailed residuals, which robust standard errors accommodate for inference but which affect the point estimate of β_1 as well. Both issues are taken up in Sections 4.4 and 5.2.

4. RESULTS

4.1 Descriptive Analysis

The COFOG data reveal considerable heterogeneity in both the level and the direction of public spending on medical products. Across the 25 countries in the analytical sample, the mean rose from 0.96 per cent of GDP in 2001 to a peak of about 1.10 per cent in 2009, eased to 1.08 per cent in 2010 and settled at 0.97 per cent in 2021, while the standard deviation moved from 0.369 to 0.360 over the same twenty years. The full list of initial and final values, growth rates and cluster assignments is given in Table 3 in Section 4.3; the dispersion statistics for selected years appear in Table 2 in Section 4.2.

Three broad expenditure profiles emerge from Table 1 and Table 3. A first group of high spenders comprises Germany, Luxembourg and Greece, which never fell below 1.3 per cent of GDP at any of the five reference dates, together with France, which started at 1.18 per cent in 2001, crossed 1.3 per cent in the second half of the 2000s and stayed above 1.4 per cent from 2010 onwards. All four are mature insurance systems with comparatively generous reimbursement. A second, more populous group, including Austria, Belgium, Spain, the Netherlands, Sweden, Lithuania and Croatia, occupies a middle band of roughly 0.7 to 1.25 per cent of GDP with limited movement over time. A third group, with Romania, Bulgaria, Ireland, Malta, Cyprus, Portugal and Hungary, shows volatile paths, either rapid growth from an initially low base or pronounced contraction associated with fiscal adjustment or reclassification.

Romania's trajectory is the most distinctive in the third group, though not in the way a raw ranking might suggest. Its 2001 level of 0.42 per cent was the third lowest among the 25 countries, above Ireland (0.28 per cent) and Malta (0.30 per cent). Between 2001 and 2014 the ratio grew at about 8.7 per cent per year, from 0.42 to 1.29 per cent of GDP, and at that point Romania stood above every country in Table 1 except Germany, Luxembourg and Greece. The subsequent contraction to 0.86 per cent by 2021 returned it below the sample mean and reduced the annualised growth rate over the whole period to 3.59 per cent, which is the third fastest in the sample after Cyprus (4.12 per cent) and Ireland (3.93 per cent). The resulting inverted-U profile is not unique. Greece traces a sharper

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version of the same shape, from 1.33 per cent in 2001 to 2.26 per cent in 2010 and back to 1.36 per cent in 2014, and Hungary and Bulgaria display growth followed by contraction with different timing and amplitude. What sets Romania apart is that the rise took it from the bottom of the distribution to its upper half in barely a decade, and that the reversal coincided with the maturing of a specific policy instrument rather than with an external adjustment programme.

4.2 Sigma-Convergence

Table 2 reports the mean, standard deviation, coefficient of variation and number of countries for selected years, and Figure 1 plots the two dispersion series for every year with their fitted linear trends.

Table 2.
Annual dispersion of public spending on medical products across 25 EU member states (% of GDP), selected years

Year	Mean	SD	CV	N
2001	0.962	0.369	0.384	25
2005	1.051	0.427	0.406	25
2010	1.079	0.430	0.399	25
2014	0.976	0.365	0.374	25
2017	0.924	0.337	0.365	25
2021	0.967	0.360	0.372	25

Note: SD is the cross-country standard deviation and CV the coefficient of variation (SD divided by the mean). Poland and Latvia excluded.

Source: IMF Government Finance Statistics (COFOG), via World Bank Data360. Author's own calculations.

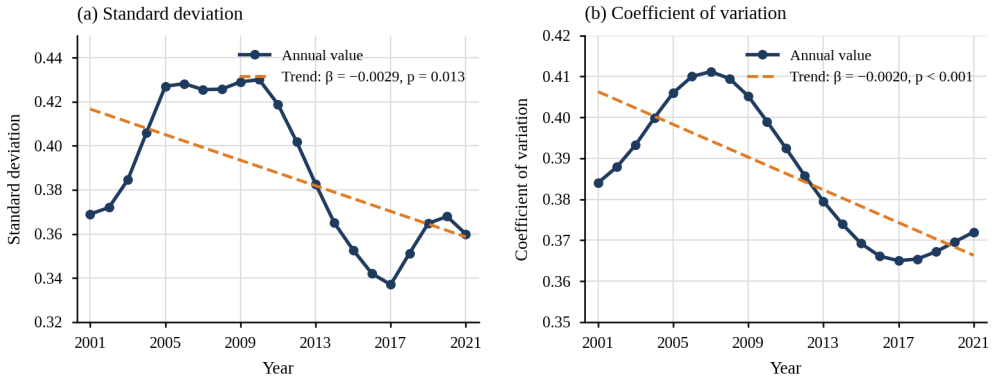


Figure 1. Sigma-convergence: (a) annual standard deviation and (b) coefficient of variation of public spending on medical products across 25 EU member states, 2001–2021, with fitted linear trends (dashed lines).

Source: Author's own elaboration based on IMF Government Finance Statistics (COFOG).

The standard deviation fell from 0.369 in 2001 to 0.360 in 2021, a small net change that conceals a pronounced hump: dispersion rose through the mid-2000s, peaked at 0.430 in 2010 as countries responded to the financial crisis in very different ways, and then fell sharply between 2011 and 2013 as the austerity programmes in the South compressed the upper tail. The ordinary least squares

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regression of the annual standard deviation on a linear trend gives a coefficient of −0.0029 ($p = 0.013$, $R^2 = 0.307$), which supports sigma-convergence at conventional significance levels. The coefficient of variation declines more steadily, with a trend coefficient of −0.0020 ($p < 0.001$, $R^2 = 0.555$), and its stronger fit indicates that the reduction in relative dispersion is not an artefact of movements in the mean. The picture is one of moderate convergence interrupted by the crisis years rather than smooth compression.

4.3 Beta-Convergence in the Cross-Section (Model 1)

Model 1, estimated on the 25 countries, yields $\beta = -0.029$ (SE = 0.006, $p < 0.001$, $R^2 = 0.473$). Initial levels alone explain 47 per cent of the variation in growth rates over twenty years, which is strong unconditional beta-convergence. Figure 2 shows the relationship, with Romania highlighted, and Table 3 lists the underlying values and the cluster assigned to each country on the basis of its growth rate and initial position.

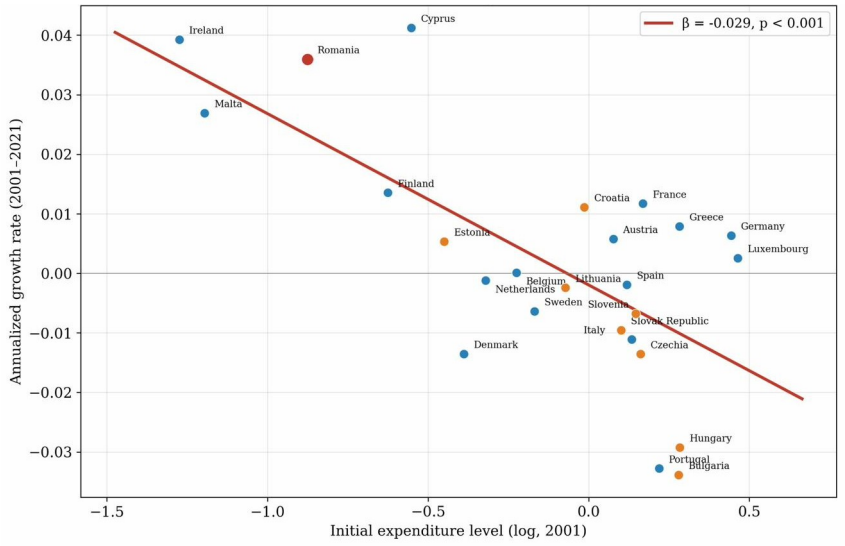


Figure 2. Beta-convergence: initial expenditure level (logarithm, 2001) against annualised growth rate, 2001–2021, for 25 EU member states. The fitted line corresponds to Model 1 (β = −0.029, p < 0.001).

Source: Author's own elaboration based on IMF Government Finance Statistics (COFOG).

Table 3.
Initial and final values, annualised growth rates and cluster assignment, 25 EU member states

Country	Initial (2001)	Final (2021)	Ann. growth (%)	Cluster
Ireland	0.280	0.613	+3.93	Catching-up
Malta	0.303	0.518	+2.69	Catching-up
Romania	0.417	0.855	+3.59	Catching-up
Finland	0.535	0.701	+1.35	Catching-up
Cyprus	0.576	1.313	+4.12	Catching-up
Estonia	0.638	0.710	+0.53	Stable
Denmark	0.678	0.517	−1.35	Declining
Netherlands	0.726	0.708	−0.12	Stable

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Country	Initial (2001)	Final (2021)	Ann. growth (%)	Cluster
Belgium	0.798	0.800	+0.01	Stable
Sweden	0.845	0.744	−0.64	Declining
Lithuania	0.930	0.886	−0.24	Stable
Croatia	0.986	1.232	+1.11	Catching-up
Austria	1.079	1.212	+0.58	Stable
Slovak Republic	1.107	0.914	−0.96	Declining
Spain	1.126	1.084	−0.19	Stable
Italy	1.143	0.916	−1.11	Declining
Slovenia	1.158	1.011	−0.68	Declining
Czechia	1.175	0.896	−1.36	Declining
France	1.184	1.496	+1.17	Stable-high
Portugal	1.245	0.646	−3.28	Declining
Bulgaria	1.323	0.672	−3.38	Declining
Greece	1.327	1.553	+0.79	Stable-high
Hungary	1.328	0.740	−2.92	Declining
Germany	1.558	1.768	+0.63	Stable-high
Luxembourg	1.591	1.673	+0.25	Stable-high

Note: Values in % of GDP, sorted by initial level. Annualised growth is the log difference between 2021 and 2001 divided by twenty. Cluster labels are descriptive and are not the outcome of a formal club convergence test.

Source: IMF Government Finance Statistics (COFOG), via World Bank Data360. Author's own calculations.

The five countries with the lowest initial levels all belong to the catching-up cluster, and the three fastest growers, Cyprus, Ireland and Romania, started from 0.58, 0.28 and 0.42 per cent of GDP respectively. Romania lies above the fitted line in Figure 2: given its starting level, it grew faster than Model 1 predicts, and Section 4.6 tries to interpret this excess. At the opposite end, Hungary, Bulgaria and Portugal sit well below the line, with contractions far larger than their initial levels alone would imply, which is consistent with the policy shocks and reclassification issues described in Section 3.2. Translated through Equation (4), the cross-section coefficient corresponds to an adjustment speed of about 4.3 per cent per year and a half-life of roughly sixteen years, figures that lie within the range usually reported for aggregate health expenditure and for income convergence.

4.4 Beta-Convergence in the Panel (Models 2 to 4)

Table 4 reports the panel estimates. Model 2, with country fixed effects and crisis dummies on 500 country-years, gives a coefficient of −0.272 (SE = 0.069, $p < 0.001$) on the lagged log level, confirming conditional beta-convergence within the panel. Both crisis dummies are positive and precisely estimated: the financial crisis years of 2009 and 2010 add 0.063 to the annual log growth rate (SE = 0.018, $p < 0.001$) and the pandemic year adds 0.070 (SE = 0.022, $p = 0.001$). Spending on medical products therefore rose, rather than fell, during both shocks, once each country's own trend is accounted for.

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Table 4.
Panel regression results, beta-convergence models

Variable	Model 2 (country FE, crisis dummies)	Model 3 (country and year FE)	Model 4 (Model 2 excl. BGR, GRC)
ln(y_t−1)	−0.272 (0.069)	−0.262 (0.073)	−0.187 (0.056)
Crisis 2009–2010	0.063 (0.018)	n/a	0.055 (0.019)
Crisis COVID 2020	0.070 (0.022)	n/a	0.068 (0.023)
Year FE	No	Yes	No
Country FE	Yes	Yes	Yes
R^2 (within)	0.203	0.245	0.170
N (countries)	500 (25)	500 (25)	460 (23)
Hausman test (p)	< 0.001	n/a	n/a

*Note: *** p < 0.01,** p < 0.05, * p < 0.10. HC3 robust standard errors in parentheses. Dependent variable: Δln(y_it), the annual log growth rate of public spending on medical products as a share of GDP. Country fixed effects estimated but not reported. The crisis dummies are absorbed by the year effects in Model 3.*

Source: Author's own calculations based on IMF Government Finance Statistics (COFOG).

Model 3 replaces the two dummies with a complete set of year effects, so that every common shock, whether macroeconomic or regulatory, is absorbed. The convergence coefficient barely moves, to −0.262 (SE = 0.073, $p < 0.001$), and the within R^2 rises to 0.245. The survival of a coefficient of this size after conditioning on both country and year effects indicates that convergence reflects country-specific adjustment towards a steady state rather than a common trend. The Hausman test rejects the random-effects alternative decisively ($\chi^2 = 72.64$, $p < 0.001$), which is expected given that the country effects are correlated with the lagged level by construction.

Removing Bulgaria and Greece, the countries with the largest single-year movements in the sample, in Model 4 brings the coefficient down in absolute value to −0.187 (SE = 0.056, $p < 0.001$) and both crisis effects remain significant, at 0.055 ($p < 0.01$) and 0.068 ($p < 0.01$). Convergence is thus not an artefact of two volatile series, but roughly a third of the estimated speed in Model 2 is attributable to them.

Applying Equation (4) to Model 2 gives an adjustment speed of about 30 per cent per year and a half-life of a little over two years; Model 4 gives about 21 per cent and a half-life of just over three years. These figures are an order of magnitude above the cross-section estimate of Section 4.3, and the gap is exactly what the literature on dynamic panels predicts. Since $\ln(y_{i,t-1})$ enters a growth equation, β_1 is one minus the autoregressive coefficient of the level, and the within estimator of that coefficient is biased towards zero in short panels, which biases β_1 away from zero (Nickell, 1981). With T = 20 the mechanical component of the bias is of the order of 5 percentage points of the autoregressive coefficient, and Hauk and Wacziarg (2009) show that the fixed-effects estimator can exaggerate convergence speed by a considerably larger margin once measurement error and heavy-tailed shocks are added. The 30 per cent figure should accordingly be read as an upper bound on the true speed of adjustment, with the cross-section estimate of about 4 per cent as a lower bound; the

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qualitative conclusion, that countries adjust towards their own steady states and do so rather quickly for a public expenditure category, does not depend on where exactly the truth lies.

4.5 Diagnostic Tests

The diagnostics confirm that the panel specification is adequate for inference while identifying where caution is needed. The Breusch-Pagan test detects heteroskedasticity (LM = 72.80, $p < 0.001$), which justifies the HC3 standard errors. The Durbin-Watson statistic of 2.08 gives no indication of first-order residual autocorrelation, and variance inflation factors are all below 1.02.

Normality is a different matter. The Jarque-Bera statistic is very large (JB = 8,248, $p < 0.001$), indicating heavy-tailed residuals. Figure 3 shows the diagnostic plots for Model 2. Panel (a) plots actual against predicted growth rates, panel (b) residuals against fitted values and panel (c) the quantile-quantile plot of the residuals. The non-normality is concentrated in a small number of observations in both tails, which correspond to the largest single-year movements in the sample: the Greek contraction after 2010, the Bulgarian and Portuguese step changes discussed in Section 3.2 and the rapid Irish expansion. Given 500 observations and robust standard errors, the departure from normality does not invalidate asymptotic inference, but it is one reason the point estimate of β_1 is treated as an upper bound.

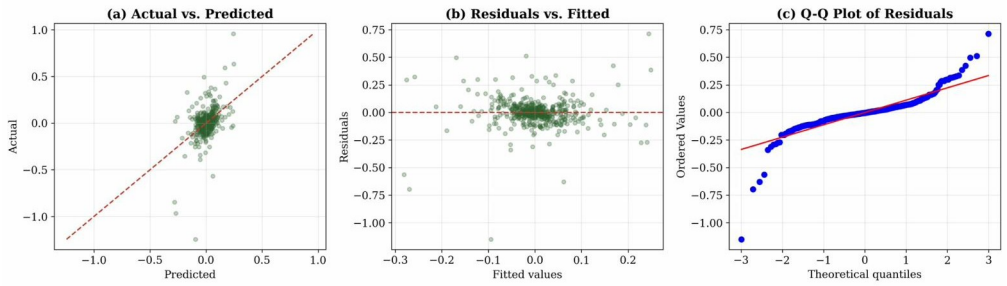


Figure 3. Diagnostic plots for Model 2: (a) actual against predicted growth rates, (b) residuals against fitted values, (c) quantile-quantile plot of residuals.

Source: Author's own elaboration.

4.6 Romania in the Convergence Framework

Figure 4 plots Romania against the mean of the 25 countries, with vertical markers at accession in 2007, the introduction of the clawback tax in 2009 and the spending peak of 2014.

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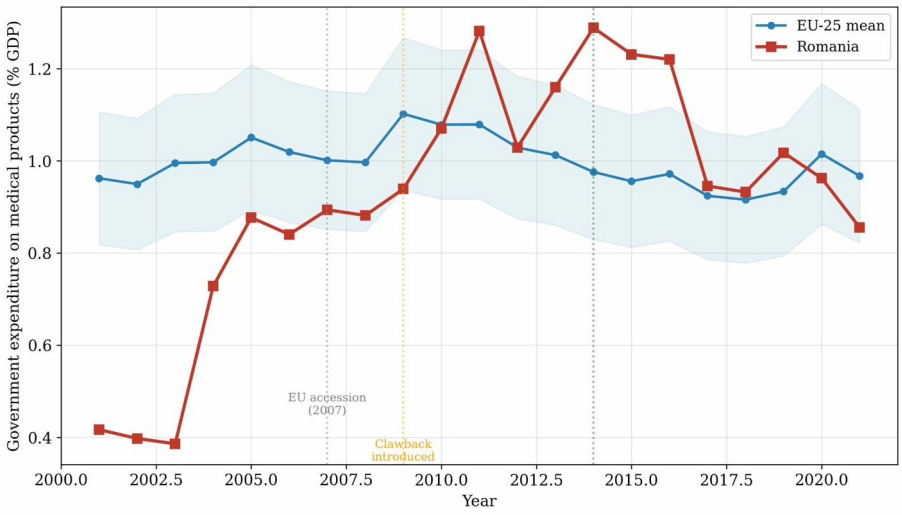


Figure 4. Romania against the EU-25 mean: public spending on medical products, appliances and equipment (% of GDP), 2001–2021. Vertical markers indicate EU accession (2007), the introduction of the clawback tax (2009) and peak spending (2014). The shaded band shows the interquartile range of the 25 countries.

Source: Author's own elaboration based on IMF Government Finance Statistics (COFOG).

The Romanian path illustrates both the possibilities and the fragility of convergence in this category. The catching-up before 2014 was substantial and fast: the ratio doubled between 2003 and 2005, reached the sample mean around 2009 and rose above it in 2011, and the annualised growth rate of about 8.7 per cent between 2001 and 2014 is far in excess of anything the cross-section slope of Model 1 would predict from the initial level. That expansion was driven by post-accession fiscal space, by the extension of reimbursement lists after a long freeze, and by rising demand in a population with a high burden of chronic disease and low prior access (Vladescu et al., 2016).

What followed after 2014 brought the ratio back to 0.86 per cent by 2021, below the sample mean of 0.97 per cent, and it cannot be assigned to a single cause. The clawback tax capped nominal growth in reimbursed consumption and, because its rate rises mechanically when consumption exceeds the reference budget, it became more binding as the budget stagnated in nominal terms while consumption grew. External reference pricing reduced unit prices, and the shift from originator to generic products lowered the average cost per prescription. Rapid GDP growth after 2015 lowered the ratio arithmetically even where nominal spending was flat. The fixed-effects estimates capture Romania's specific position through the country intercept, but disentangling these mechanisms would require data on volumes, prices and reimbursement decisions that COFOG does not contain.

5. DISCUSSION

5.1 What Drives Convergence in Pharmaceutical Budgets

Public spending on medical products converged across the Union between 2001 and 2021 by both standard criteria: dispersion fell, and countries that started low grew faster. Is this the product of

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deliberate harmonisation, of income convergence, or of structural pressures that push pharmaceutical budgets towards a common equilibrium irrespective of policy intent?

Our evidence points to a mixed answer. The strength of unconditional beta-convergence in Model 1, where initial levels explain 47 per cent of subsequent growth, is consistent with a structural catching-up process in which low-spending countries face rising demand for medicines that their budgets must eventually accommodate. The persistence of a large and significant coefficient in Model 3, after conditioning on both country and year effects, rules out the reading that the finding is merely a common trend or a by-product of simultaneous income growth. This much aligns with the literature on aggregate health expenditure (Hitiris & Nixon, 2001; Nghiem & Connelly, 2017).

Divergent trajectories among countries with similar starting points nonetheless point to a substantial role for national policy that the aggregate statistics obscure. Romania and Bulgaria are the clearest contrast, though not the one a superficial reading might expect: Romania started near the bottom of the distribution at 0.42 per cent and roughly doubled its ratio, whereas Bulgaria started near the top at 1.32 per cent and halved it. Hungary declined steeply after a peak of 1.64 per cent in 2005, while Czechia eroded gradually from 1.33 per cent in 2005 to 0.90 per cent in 2021. Portugal moved from 1.60 per cent in 2005 to 0.38 per cent in 2014 under an adjustment programme that targeted pharmaceutical expenditure specifically (Karanikolos et al., 2013), with the reclassification caveat noted in Section 3.2. Aggregate convergence coexists with pronounced divergence in individual paths, a pattern reminiscent of the convergence club hypothesis (Phillips & Sul, 2007; Panopoulou & Pantelidis, 2012), although the time dimension available here is too short for formal club testing and the cluster labels in Table 3 are descriptive only.

Crisis effects deserve separate comment. Both dummies are positive and significant in Models 2 and 4, which means that, relative to each country's own trend, spending on medical products rose during the financial crisis and during the pandemic. For 2020 the reason is obvious: emergency purchases of protective equipment, tests and therapeutic agents, which fall squarely within group 07.1 (European Court of Auditors, 2022). For 2009 and 2010 the result is less intuitive, since these were the years of the pharmaceutical price cuts and new manufacturer taxes catalogued by Vogler et al. (2011). The explanation is partly arithmetic, because GDP fell sharply in 2009 while pharmaceutical consumption is slow to adjust, so the ratio rose even where nominal spending was flat, and partly a matter of timing, because the austerity measures took effect from 2011 onwards, precisely when the dispersion series in Figure 1 collapse. Crisis years thus produced temporary upward deviations rather than a break in the convergence process, which is consistent with the account of crisis-period health policy in Mladovsky et al. (2012).

5.2 How Fast, and How Much to Trust the Speed

An implied adjustment speed of about 30 per cent per year, as in Model 2, is far above the 2 to 5 per cent range typical of income convergence and of aggregate health expenditure. Two interpretations are

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available, and they are complementary rather than competing. The first is substantive: pharmaceutical spending is more directly controlled by policy instruments than most public expenditure categories, and price cuts, reimbursement decisions and procurement reforms can move the trajectory within a year or two, as the Romanian and Portuguese cases show. On this reading a fast adjustment speed is what one should expect from a category governed by annual budget ceilings and quarterly clawback settlements.

A second interpretation is statistical, and Section 4.4 has already set it out. The within estimator of a dynamic panel with twenty periods overstates convergence (Nickell, 1981; Hauk & Wacziarg, 2009), the growth-rate dependent variable is volatile, and the drop in the coefficient from −0.272 to −0.187 when two countries are removed shows how sensitive the speed is to a handful of extreme observations. The honest conclusion is that the true speed lies between the 4 per cent of the cross-section and the 30 per cent of the panel. What survives every specification is the sign, the significance and the ordering: pharmaceutical budgets converge, they converge faster than total health spending, and the process is punctuated rather than reversed by crises. Bias-corrected estimators that would narrow the interval, such as system generalised method of moments, are poorly suited to a panel of 25 units and are left for future work with a longer series.

5.3 Implications for Pharmaceutical Policy

For lower-spending member states, the results carry two messages that pull in different directions. Catching-up is achievable within a short policy horizon: Romania moved from the bottom of the distribution to its upper half in roughly a decade. Gains can be reversed just as quickly, as the Romanian path after 2014 and the Portuguese path after 2010 both show. That a single instrument, the clawback tax, bent the trajectory of an entire expenditure category within a few years illustrates the leverage available to national authorities, and also the risk that cost-containment instruments restrict access when they are not recalibrated (Vladescu et al., 2016; OECD & European Observatory on Health Systems and Policies, 2023).

The second message concerns institutional capacity. Higher pharmaceutical budgets deliver better access only when procurement, health technology assessment and expenditure control keep pace with the money. Vasile and Croitoru (2020) argue that autonomous administrative structures with clear accountability improve the management of public resources, and the argument applies with particular force to a category where a few hundred products account for most of the spending and where price negotiations are repeated annually. Nicolau (2023) points to the potential of artificial intelligence in audit and monitoring to track expenditure in near real time and to flag systematic deviations; for a health insurance fund settling clawback claims every quarter, such tools would be directly useful. The European policy environment is moving in the same direction, with joint procurement mechanisms and the proposed revision of the pharmaceutical legislation aiming to reduce the price dispersion that

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drives part of the expenditure differences observed here (Vogler et al., 2021a; European Commission, 2020, 2023).

A final implication concerns ageing. The 2024 Ageing Report projects public health spending to rise by close to one percentage point of GDP on average by 2070 (European Commission, 2024). If pharmaceutical budgets converge as quickly as the panel suggests, that pressure will be shared more evenly across member states than current levels imply, and so will the exposure to price shocks in the market for new medicines.

6. CONCLUSIONS

Member states of the European Union are becoming more alike in the share of national income their governments devote to medical products, appliances and equipment, a functional category dominated by pharmaceuticals. Across 25 countries over 2001–2021, the cross-country standard deviation and coefficient of variation both decline, with trend coefficients of −0.0029 ($p = 0.013$) and −0.0020 ($p < 0.001$), and initial levels explain 47 per cent of subsequent growth in a cross-section regression with $\beta = −0.029$ ($p < 0.001$). The panel estimates confirm conditional convergence with country effects alone ($\beta_1 = −0.272$, $p < 0.001$) and with country and year effects together ($\beta_1 = −0.262$, $p < 0.001$), and the Hausman test supports the fixed-effects specification. The financial crisis and the pandemic both raised spending temporarily, relative to each country's own trend, without reversing the process.

The speed of adjustment is the finding that requires the most care. The panel coefficient implies about 30 per cent per year, but the within estimator with twenty time periods is known to overstate convergence, and the estimate drops by a third when two volatile countries are excluded. This article therefore presents the 30 per cent figure as an upper bound and the 4 per cent implied by the cross-section as a lower bound, and concludes that pharmaceutical budgets converge faster than total health spending without claiming a precise rate.

Romania's trajectory illustrates both sides of the argument. Its growth of about 8.7 per cent per year between 2001 and 2014, from the third lowest level in the sample to the upper half of the distribution, shows that rapid catching-up is achievable when fiscal space expands and demand accumulates. The contraction after 2014, driven by the clawback tax, reference pricing and generic substitution against a background of fast GDP growth, shows equally clearly that convergence gains can be undone when cost-containment instruments are left to operate without recalibration. Romania is neither the lowest starter nor the fastest grower in the sample, but it is the country whose path is most obviously shaped by identifiable policy decisions, which is what makes it instructive.

The study has limitations that define its scope. Group 07.1 aggregates medicines, other medical products and appliances, and the three-digit detail that would isolate pharmaceuticals is not available for all countries and years. The step changes in the Portuguese and Bulgarian series, and the anomalous values for Poland and Latvia, are evidence that COFOG classification practice is not fully harmonised across member states, and the robustness checks mitigate rather than eliminate this

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problem. The panel does not include time-varying conditioning variables such as income per head, age structure or governance indicators; country fixed effects absorb the time-invariant part of these influences but not their evolution. Convergence in spending does not imply convergence in efficiency or in outcomes, since a country can spend more without spending better. The series end in 2021, so post-pandemic normalisation and the effects of the Union's new procurement and legislative initiatives cannot yet be assessed.

Future research could proceed in three directions. The first is to extend the panel as further years are published and to apply bias-corrected dynamic panel estimators, which would narrow the wide interval around the adjustment speed reported here. The second is to combine the COFOG series with data on volumes, prices and reimbursement decisions for a subset of countries, so that the mechanisms behind the Romanian and Portuguese reversals can be identified rather than inferred. The third is to relate convergence in public pharmaceutical spending to convergence in financial protection, since the policy objective is not the level of the budget but the share of households that can afford the medicines they need.

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AUTHOR CONTRIBUTIONS

Conceptualisation, M.D.S.; methodology, M.D.S.; software, M.D.S.; formal analysis, M.D.S.; data curation, M.D.S.; writing, original draft, M.D.S.; writing, review and editing, M.D.S. The author has read and agreed to the published version of the manuscript.

DATA AVAILABILITY

The analysis uses general government expenditure under COFOG group 07.1 (medical products, appliances and equipment) as a percentage of GDP from the IMF Government Finance Statistics, accessed through the World Bank Data360 platform under indicator code IMF_COFOG_GELM_GF0701, cross-checked against the Eurostat dataset gov_10a_exp (general government expenditure by function). Both sources are publicly available. The compiled panel, the reconciliation notes and the estimation code are available from the author on reasonable request.

DECLARATION OF INTEREST

The author declares no competing interests.

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