Departament d'Economia Aplicada
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David Card
Ana Rute Cardoso
Pedro Luis Silva

Departament d'Economia Aplicada
Edifici B
Universitat Autònoma de Barcelona
08193 Bellaterra, Barcelona, Spain.
d.econ.aplicada@uab.cat
www.uab.cat/en/applied-economics
@ecapuab.bsky.social

UAB
Universitat Autònoma de Barcelona

Sharing the Burden:
The Impacts of Pharmacy Sector Reforms on the Labor Market for Pharmacists in Portugal[*]

David Card
UC Berkeley
and NBER

Ana Rute Cardoso
IAE-CSIC
and Barcelona SE

Pedro Luis Silva
Universitat Autònoma
de Barcelona and CIPES

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ABSTRACT

In the depths of the 2010 financial crisis the Portuguese government enacted a series of reforms in its prescription drug reimbursement system. Over the next three years value added per pharmacist in retail pharmacies fell by a third, reflecting a rise in generic substitution and reductions in the markups allowed for prescription drugs. This massive shock led to pay cuts for incumbent pharmacists and the introduction of a two-tier pay system for new hires, with little or no reduction in the growth of employment. We use detailed longitudinal records from the Quadros de Pessoal data base, merged with information on collective bargaining settlements and firm financial records, to study the impacts of the reforms. We estimate that between 2009 and 2022 average wages of pharmacists fell by a third; most of this reduction was due to lower wages for newly entering cohorts. The implied responsiveness of wages to productivity is substantially above most estimates in the rent-sharing literature, arguably reflecting the strong attachment of workers to the sector and the steady inflow of newly graduating pharmacists. Stepping back, we then consider how wages of pharmacists have diverged relative to wages of other health care professionals in Portugal, and the decisions of recent college applicants to enter the profession.

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How do labor markets respond to large negative shocks? The literatures on deregulation (e.g., Rose, 1987; Hendricks, 1994; Card, 1997) and plant closings (Jacobson Lalonde and Sullivan, 1993; Schmeider, von Wachter and Heining, 2023) suggest that large negative shocks can have lasting effects on workers' wages. Studies of geographically concentrated demand shocks (Yagan, 2019) and trade-induced shocks (Autor et al., 2014; Yi, Müller, and Stegmaier, 2024) find persistent impacts on exposed workers. And studies of early career shocks find effects lasting a decade or more (von Wachter and Bender, 2006; Oreopoulos, von Wachter and Heisz, 2012). In all of these settings, worker mobility is a key mechanism limiting the impact of negative shocks.[1] What happens when the workers affected by a shock have industry-specific skills and cannot easily find comparable jobs in other sectors?

We study the impacts of such a shock, originating from a series of policy changes introduced by the Government of Portugal between 2010 and 2014 to lower the costs of prescription drugs sold by community pharmacies. As in most European countries, pharmacies in Portugal are highly regulated: they purchase drugs at regulated wholesale prices and dispense them at prices determined by a rigid markup formula.[2] Policies that lowered the wholesale prices paid by pharmacies, cut the markups for dispensing drugs, and encouraged substitution of generics for name-brand drugs led to a 40% reduction in average margins per filled prescription (Teixeira et al., 2018). Figure 1 shows that real value added per pharmacist in the industry fell by a similar percentage in response to this shock.

Most pharmacists in Portugal work under a sectoral bargaining agreement that sets a wage floor for each level of experience. In addition, pharmacists are often paid a "cushion" above their wage floor (Cardoso and Portugal, 2005) and various premiums and supplements. Contract negotiations in 2010 reset the system of wage floors, leading to a reshuffling of workers to lower floor categories that was only partly offset by rises in their corresponding cushions. More dramatically, negotiations in 2012 introduced a lower tier of wage floors for new hires, with a slower pace of promotions between floor categories. Given the relatively

[1] Indeed, in a classic study Blanchard and Katz (1992) concluded that mobility completely offset any long run wage impacts of regional shocks in the US labor market. See also Notowodigdo (2020).

[2] As explained below, prescription drug costs in Portugal are mainly covered by the government through a reimbursement system, supplemented by patient co-payments.

high rates of entry by newly graduating pharmacists and some job-to-job mobility among senior workers, by 2018 over 60% of pharmacists were covered by the lower floors. As shown in Figure 1, the combination of lower floors for newly hired workers and some reduction in real wages for incumbent workers led to a 34 percent reduction in average salaries of pharmacists between 2009 and 2018 – nearly as large as the fall in productivity.

We combine matched employee-employer data from Quadros de Pessoal (QP), an annual census of employees, with firm-specific balance sheet information from the System of Integrated Accounts (SCIE), and data on collective bargaining agreements published in the Labor Bulletin (Boletim do Trabalho e Emprego, or BTE) to study the effects of the reforms on pharmacists. These data provide a comprehensive picture of outcomes for workers and firms in the community pharmacy sector, where about two-thirds of all certified pharmacists are employed.[3] Unfortunately, there are no comparable data for hospitals, which make up the largest alternative employer of pharmacists (about 10% of all jobs), but are missing from QP. Nevertheless, positions in hospital pharmacies typically require additional training beyond that needed for a community pharmacy job, and the number of hospital positions appears to have grown relatively slowly over the past two decades, so we believe the impacts of the government's policy changes were largely concentrated on pharmacists in the private sector.

Using the available data on the community pharmacy sector we reach three main conclusions. First, most of the reduction in real wages shown in Figure 1 was attributable to the fall in wages for workers entering new jobs after 2012. Under the 2012 contract, the wage floor for newly hired pharmacists was set 24% below the floor that existed in earlier years, with a slower progression to higher categories. In addition, many newly hired pharmacists received base wages *below* their contractually specified floors (i.e., negative wage cushions) – a departure from the usual custom in Portugal. Taken together, these features meant that newly hired pharmacists earned about 40 percent less than incumbent pharmacists: a gap that pushed down the average wage steadily after 2012. The balance of the reduction in average wages was

[3] Appendix Tables 1 and 2 show data on the numbers of retail pharmacies and the number of pharmacists in mainland Portugal, respectively.

attributable to the effects of inflation (given the absence of nominal wage adjustments after the 2010 contract negotiation) and a reshuffling of incumbent workers across floor categories.

Our second conclusion is that despite the fall in value added per worker, and in average wages, the number of pharmacists working in community pharmacies in Portugal grew relatively steadily after 2009, at close to 3% per year.[4] The rise in employment despite falling wages is consistent with a simple model in which qualified pharmacists have few outside opportunities and the supply of new pharmacists is driven by flows of newly graduating students that are relatively unresponsive to current wages.

Our third conclusion is that the response of wages to the fall in industry-wide productivity was far larger than would have been predicted by standard rent-sharing models linking *firm-specific* productivity shifts to firm-specific wage outcomes. Fitting such models to the data for community pharmacists in Portugal we obtain elasticities well within the 0-0.2 range of estimates in the literature summarized in Card et al. (2018). Previous work has shown that the response of wages to industry-wide shocks can be larger than the responses to firm-specific shocks (e.g., Carlsson et al., 2016); we find that the responses to industry-wide shocks are an order of magnitude larger, with an elasticity close to 1.

Moving to a longer run perspective, we summarize three other pieces of evidence regarding the labor market for pharmacists in Portugal. First, using QP data to 2022, we find that real wages of newly entering pharmacists rebounded somewhat after 2018, but are still substantially below the wages of workers hired before 2012. Second, comparing data from 2008 to 2022 for Portugal and the U.S. on the annual earnings of pharmacists versus medical doctors and nurses – two of the most important alternative university programs for applicants to pharmacy degree programs in Portugal -- we show that pharmacists' relative wages have fallen substantially in Portugal. In 2008, pharmacists in both countries earned about 40% per year more than registered nurses. By 2022 that gap had fallen to around 30% in the U.S. but

[4] International comparisons published by the OECD show that the number of practicing pharmacists per capita rose between 2011 and 2021 more quickly in Portugal than in most other OECD countries (OECD, 2021, Figure 9.4). As of 2021, Portugal had 28 pharmacists per 100,000 population, the same as the OECD average and somewhat lower than in Canada (30 per 100,000) but higher than in Germany (23 per 100,000) (OECD, 2023, Figure 9.5).

had almost been eliminated in Portugal. We are unaware of other examples of such a large change in occupational wage differentials over such a short time.

Finally, we use data on university applicants and graduates in the 2005-2024 period to see whether the sharp decline in the wages of pharmacists -- and the obvious problems faced by the retail pharmacy industry – had any impact on students' propensity to apply for undergraduate pharmacy programs, or on the inflow rate of new pharmacists. We find that the number of graduating pharmacists per year has fallen since 2015. Nevertheless, even by the early 2020's the annual inflow rate of new graduates was equivalent to about 4% of the stock of qualified pharmacists – enough to sustain continuing employment growth. The relative quality of students applying to pharmacy programs – as measured by the rank of their high school GPA's – has deteriorated somewhat since 2013, though the field is still attracting above-average students.

Our paper contributes to several literatures, including an older body of work on the labor market effects of product market deregulation (see Peoples, 1998). Rose (1987) concluded that deregulation of the U.S. trucking industry in the late 1970s led to a reduction in the wages of unionized truck drivers (who typically worked in regulated sectors of the industry) relative to non-union drivers (who often worked in unregulated sectors), while also contributing to a fall in the share of drivers covered by unions.[5] Card (1996) studied the effect of airline deregulation in the U.S., and concluded that it led to a decline in the wages of most groups of workers, with no clear impact on output or employment. Surprisingly, these declines were only slightly larger for pilots, who have highly specific skills and were perceived as earning substantial rents in the regulatory era. Our analysis extends this literature by measuring the size of the regulatory shock to productivity, by isolating different channels of wage adjustment, and by examining impacts on the long run supply of workers to the industry.

We also contribute to the broader rent sharing literature in labor economics. The regulations governing community pharmacies in Portugal make these firms price takers in the prescription drug part of their business, helping to alleviate concerns about endogeneity of

[5] Hirsch (1988) presents a related analysis, distinguishing between different parts of the trucking industry.

value added that have been highlighted in the existing literature.[6] We add to this literature by estimating the responses of wages to both firm specific and industry-wide productivity shocks for workers with highly specific skills.

Finally, our work adds to a small body of research on the use of two-tiered labor contracts in collective bargaining.[7] Collective agreements with lower wages for new hires became widespread in the U.S. airline industry in the 1980s (see Walsh, 1988; and Card, 1996), and subsequently spread to other industries, including the auto sector.[8] Our analysis shows the importance of such contract provisions in the wage adjustment process and quantifies their net impact on wages in the pharmacy sector.

I. The Setting

a. Regulatory Framework

Community pharmacies in Portugal are highly regulated. Each pharmacy is assigned a market area, with a minimum distance to its closest competitor. Entry of new pharmacies is only allowed if there are 3500 or more new clients in an area.[9] Traditionally, each pharmacy had to be independently owned by a qualified pharmacist. This rule was lifted in 2007, allowing non-pharmacists to assume ownership but restricting owners to a maximum of 4 outlets. As shown in Appendix Figure 1, over our sample period there was a steady shift in the ownership status of pharmacies from sole proprietorships to incorporated businesses, potentially reflecting a response to this law as well as other background factors.

[6] Kline et al. (2019) circumvent these concerns by studying the effects of patents applications that are allowed or rejected by the U.S. Patent Office on the wages of workers at the applying firms. Interestingly, their implied estimate of the elasticity of wages with respect to productivity, as measured by value added per worker, is close to 0.5, at the high end of the existing literature.

[7] We use the "two-tier" terminology following North American usage. In Europe "two-tier contracts" can mean situations where employers offer both fixed term and permanent contracts (e.g., Centeno and Novo, 2011), or situations where firm-level bargaining adds additional terms to sectoral agreements (e.g., Boeri, 2014).

[8] In their annual review of collective bargaining agreements, the Bureau of National Affairs found that 28 percent of their (nonrandom) sample of agreements had two-tier wage plans in 1989 (Bureau of National Affairs 1995) and 31 percent in 2008 (Bureau of National Affairs 2008).

[9] WHO (2019, Table 2) shows that similar market size regulations are present in many other European countries, including Austria, Belgium, France and Spain. Bilka et al. (2023) study market entry of pharmacies in Portugal, focusing on the relationship between the population in a given municipality and the number of pharmacies. They report that about 40% of municipalities in Portugal had 6 or fewer pharmacies in 2020.

Pharmacies also face strict price regulations. They buy drugs from wholesalers at regulated prices and dispense prescriptions at a regulated margin over the wholesale price. In the years just prior to the crisis the margin was set at 20%. Patient costs of prescription drugs are mainly covered by the National Health Service (*Serviço Nacional de Saúde* or SNS), with modest co-payments collected at the time of dispensing. Pharmacies submit their claims for reimbursement to Finanfarma, a financial intermediary owned by the major pharmacists' association (the National Association of Pharmacies or ANF), which issues payments and bills the government.[10]

In addition to prescription drugs, pharmacies in Portugal also sell over the counter (OTC) drugs, health supplements, and beauty aids (like shampoo and sunscreen). In fact, prior to 2005, pharmacies were the only firms allowed to sell most OTC drugs in Portugal,[11] and even today non-pharmacy outlets are required to keep OTC drugs in locked cabinets that can only be accessed with a store assistant. Moura and Barros (2020) conclude that the opening up of the OTC market led to some loss in the profitability of pharmacies, though even as recently as 2021 80% of OTC drugs in Portugal were sold by pharmacies (Tavares et al., 2023).

b. Supply of Pharmacists

Pharmacists enter the profession by completing a master's degree in pharmacy science.[12] Since implementation of the EU's Bologna framework, high school students apply directly to an integrated undergraduate/masters program (*Mestrado Integrado em Ciências Farmacêuticas* or MICF) at one of 7 public or 5 private universities.[13] As discussed in Section VIII below, applicants tend to have above-average high school grades, though not as high as those

[10] Throughout the 1970s and 1980s the Portuguese government was often late in paying reimbursements and Finanfarma was devised as a way to ease the cash flow problems of the many small pharmacies in the country. See Ladi et al. (2024).

[11] Currently, a similar rule still applies in Germany, Finland and Belgium.

[12] Pharmacists are accredited by the Order of Pharmacists (*Ordem dos Farmacêuticos*). Students who complete a MICF are eligible for accreditation. Pharmacists have to renew their license every 5 years, with credits toward renewal awarded for active employment as a pharmacist and for professional development activities.

[13] Prior to the Bologna reforms, students applied to a Bachelor's program in Pharmacy, then those wishing to become qualified pharmacists entered a master's program.

applying to medicine or some engineering fields. The vast majority (close to 80%) of applicants are women, closely paralleling the female share of registered pharmacists.[14]

Portuguese universities also offer undergraduate degrees in pharmacy. Graduates of these programs must subsequently complete a master's degree to become qualified as a pharmacist, but can work as a pharmacy technician at community pharmacies, or in a variety of other roles in the health care and drug production/distribution industry.

c. Efforts at Reform Prior to the Financial Crisis

In the years prior to the financial crisis, governments in Portugal adopted a series of reforms that were designed to lower the price of prescription drugs and reduce the profits earned by community pharmacies. Ladi et al. (2024) summarize these efforts, noting that one of the first statements of newly elected Prime Minister José Sócrates and his health minister after the 2005 election was that "… they wanted to curb the privileges of pharmacies and the power of the ANF" (Ladi et al., 2024, p. 196).

Between 2005 and 2010 the government passed laws opening up the sale of OTC drugs to grocery stores and other outlets (Decree Law 134/2005), and allowing non-pharmacists to own pharmacies (Decree Law 307/2007). A proposal was introduced in 2008 to lower the 20% "dispensing fee" markup charged by retail pharmacists on prescription drugs. This was ultimately set aside, but lobbying efforts by the ANF to prevent the cut were uncovered in a corruption investigation against the Prime Minister (Ladi et al., 2024), adding to the public perception that pharmacies were exerting undue influence in the political process.

Ladi et al. (2024) contrast the cuts imposed on the pharmacy industry in Portugal during the financial crisis to the situation in Greece, where the government and the international agencies overseeing the Greek bailout left the pharmacy sector largely alone. They argue that

[14] Goldin and Katz (2016) present pharmacy as an exemplar of a family-friendly job, emphasizing the wide availability of part time jobs and the absence of career penalties for part time work or extended leaves. The share of females in pharmacy is about the same in the U.S. and Portugal, and the gender wage gap is also very small in both countries, but 90% of pharmacists work full time in Portugal versus about 80% in the U.S., according to data from the American Community Survey, which we use below.

negative perceptions of the ANF and the community pharmacy sector, which had been built up over many years, were key factors that led to the large cuts in Portugal.[15]

d. Collective Bargaining

The system of collective bargaining in Portugal was established in the 1970s and is broadly similar to systems in Austria, Italy, Netherlands, and Spain (see Card and Cardoso, 2022 for more details). Typically, employer associations representing the firms in a particular industry sign agreements with one or more trade unions. Although these agreements technically cover only union members, in practice employers extend the agreements to their entire workforce, regardless of membership status. In addition, the terms of the agreement are often extended to other firms in the same sector by government decree, leading to collective bargaining coverage rates close to 90%. In the case of community pharmacies, contracts for pharmacists are signed between the National Association of Pharmacies (ANF) and the National Trade Union of Pharmacists. Given that the overwhelming majority of pharmacies are members of the NAF, the contracts apply to most firms. Within a pharmacy, the terms of the agreement are extended to all pharmacists, irrespective of union membership status, similar to the case in other sectors.

Other employees in community pharmacies are covered by other agreements. For example, pharmacy technicians are represented by the Portuguese Association of Pharmacy Technicians (APLF), who also negotiate with the ANF. Clerical workers and cleaners are typically covered by agreements covering retail trade workers. Owing to the large number of other unions involved, in this paper we do not analyze the collective agreements covering non-pharmacists, though we present a brief analysis of their wage trends below.

Collective bargains in Portugal set wage floors (i.e., minimums) for broad occupation groups in each sector. A typical agreement will have 4-10 floors: prior to 2010 the pharmacist agreement had had 4 separate wage floors for registered pharmacists in their first, second, third, and fourth and higher years on the job, and a fifth category for the Technical Director of

[15] Ladi et al. (2024, page 196) report that between 2005 and 2021 there were 35 editorials in the two newspapers of record in Portugal criticizing the power of the ANF and pharmacies.

each pharmacy. A given worker's wage will also typically include a component above the wage floor – which Cardoso and Portugal (2005) labelled their "wage cushion".[16] This component – which typically averages about 10% of the floor -- is not guaranteed by the agreement, though a worker's base wage (their floor plus their cushion) cannot be reduced except under special circumstances. In addition, most workers receive supplements and premiums (e.g., for work outside normal hours) and a meal allowance that together with their floor and cushion comprise their "total" wage, which is typically around 20% higher than their base wage and 30% above their wage floor.

II. Conceptual framework

Before describing the reforms during the financial crisis it is useful to briefly discuss the conceptual framework we use to interpret these reforms. Assume for simplicity that pharmacies sell only a single brand name drug and a single generic version of the drug. A pharmacy buys drugs from wholesalers at regulated prices and sells them at a fixed markup. If the wholesale price of the brand-name version of the drug is c^p and the markup over the wholesale price is m^p, then revenue from the sale of brand name prescription drugs is $R^p = y^p(1+m^p)c^p$ where y^p is the number of prescriptions filled for the brand name version of the drug in the relevant time interval. Similarly, if the wholesale price of the generic version of the drug is c^g and the markup over the wholesale price is m^g, then revenue from the sale of generic prescription drugs is $R^g = y^g(1+m^g)c^g$ where y^g is is the number of generic prescriptions filled. The value-added of the pharmacy in filling prescription drugs in the time interval is therefore:

$$VA = R^p + R^g - y^p c^p - y^g c^g = m^p y^p c^p + m^g y^g c^g$$

Value added per full time equivalent pharmacist is:

$$v \equiv VA/N = \frac{y}{N}(sm^p c^p + (1-s)m^g c^g) \qquad (1)$$

[16] As discussed by Card and Cardoso (2022) the presence of wage cushions means that two workers in the same occupation category do not necessarily receive the same wage. This is different than the case in North America or the U.K., where collective bargains set the wage for a given job.

where N is the number of pharmacists (measured in full time equivalents), $y = y^p + y^g$ is the total number of prescriptions filled, and $s = y^p/y$ is the share of prescriptions that are brand name versus generic.

Equation (1) is very similar to the expression for value added per worker for a competitive firm with exogenous input and output prices. In particular, value added per worker is the product of average labor productivity and a net margin per prescription:

$$M \equiv sm^p c^p + (1-s)m^g c^g. \quad (2)$$

For a given pharmacy, wholesale drug prices c^p and c^g and the margins m^p and m^g are fixed. There are only two channels through which a pharmacy can affect value added per unit of pharmacist labor: by improving labor productivity (i.e., by raising y/N) or by raising the share of brand name versus generic drugs that it sells. A concern that was often expressed by policy makers in Portugal prior to the crisis was that pharmacists tended to steer patients toward more expensive brand name drugs in an effort to raise their profits.

Of course, individual pharmacies also differ in the characteristics of nearby customers, leading to variation in their margins. A pharmacy in a wealthy urban area would likely see higher overall demand (since richer people typically consume more prescription drugs per capita) and higher net prices for these drugs (since richer consumers tend to prefer brand name drugs). From the point of view of pharmacy regulators, however, M can be manipulated by changing the wholesale prices for drugs, by changing the margins allowed for pharmacists, or by pressuring doctors to change their prescribing practices for generic versus name brand drugs. As we discuss in the next section, during the crisis period all three factors were changed, leading to relatively large reductions in M.

Finally, it is important to keep in mind that pharmacies sell a range of other products and services in addition to prescription drugs, and hire pharmacy technicians and other workers in addition to registered pharmacists. Pharmacy technicians, salespeople and other service workers make up over 60% of pharmacy workforces. Fully accounting for the value of non-prescription goods and services and the contributions of the other types of workers makes the measurement of changes in the productivity of pharmacists more difficult. In the analysis below we focus on value added per pharmacist, though we have also conducted most of our analysis

using value added per pharmacy employee. As we show, these two variables behaved very similarly between 2009 and 2012 but diverged between 2012 and 2016 before resuming parallel trends.

III. Regulatory Changes During the Financial Crisis

a. The Crisis

After relatively strong growth in the 1980s and 1990s, Portugal joined the Eurozone in 2000 and subsequently experienced a decade of extensive capital inflows but slow growth (Blanchard, 2007; Reis 2013). The situation was worsened by the impacts of the 2008 global financial crises, leading to rising deficits and pressure to cut government expenditures. In April 2011 the Government of Portugal requested a financial bailout, and a Memorandum of Understanding with the "Troika" of agencies set up to finance the bailout (the European Commission, the European Central Bank, and the International Monetary Fund) was reached in September of the same year.

b. Changes in 2010

In the year prior to the bailout the government introduced a number of administrative changes to the prices of drugs, including reductions in the maximum prices for pharmaceutical products.[17] It also introduced efforts to increase the prescribing of generic drugs. Calculations reported by Teixera et al. (2018, Table 3) based on drug consumption and pricing data for most of the pharmacies in Portugal show that the net margin per prescription (i.e., M in equation 2) fell from €2.14 in 2010 to €1.78 in 2011 – a reduction of 17%. In addition, the introduction of higher co-payments for many drugs reduced government costs and may have had some effect on drug demand (Donato et al., 2024). Consistent with this, Barros (2012, Figure 1) reports that public expenditures on retail pharmacy reimbursements fell from 1.0% of GDP in September 2010) to 0.75% in December 2011 – a reduction of 25% that was 7 ppt larger than the cut in pharmacy margins.

[17] The cuts in maximum prices are mentioned by Barros (2012) and Teixera et al. (2018) but neither source precisely identifies the nature of these cuts.

c. Changes under the Troika Agreement

The MOU between the Portuguese government and the Troika included various provisions affecting the retail prescription drug prices.[18] Effective at the signing date were a set of changes focused on generic substitution, including:

(i) allowing pharmacists to substitute generics for name brand drugs

(ii) changing the reference price system that set the wholesale price for generic drugs to use prices in countries with relatively low prices as a basis

(iii) automatically lowering the price of a brand-name drug when its patent expired

(iv) setting prices for the first generic to enter a market at expiration of the patent for the corresponding brand-name drug.

The MOU also proposed to reduce the scope for lawsuits used by the major drug companies to slow the introduction of generic drugs to the Portuguese market.

In addition to these provisions, the MOU specified changes in the margin formulas used by wholesalers and retail pharmacies to set their prices. The change in the wholesale margin formula lowered the prices paid by pharmacists, while the change in the retail margin formula lowered the average markups could earn (i.e., it lowered the terms m^p and m^g in equation 1).

Teixeira et al. (2018, Table 3) use prescription-level data to estimate the average margins (M) for retail pharmacies between 2010 and 2014. These fell from €2.14 per prescription in 2010 to €1.78 in 2011, €1.37 in 2012, €1.28 in 2013, and €1.24 in 2014: a cumulative reduction of 42% between 2010 and 2014. Factoring in the 5.9 percentage point increase in consumer prices, this was equivalent to a 48% reduction in the "price" component of real value added per worker in equation (1). Interestingly, nearly half of this reduction was achieved between 2010 and 2011, prior to the margin formula changes or the institutional changes targeted by the MOU. As shown in Appendix Figure 2, there were relatively rapid rises in the share of generic prescriptions in Portugal throughout the 2005-2014 period, with a particularly large increase from 2009 to 2011. Given the price differences between brand name

[18] The MOU had 10 paragraphs devoted to the retail pharmacy sector (Council Implementing Decision 2011, paragraphs 3.54 to 3.63). See Barros (2012), Teixeira et al. (2013), Teixeira et al. (2018) for more details.

and generic drugs, these changes contributed to the fall in pharmacy margins prior to the changes introduced in the 2012 MOU.

IV. Data and Analysis Sample

a. Data Sources

To address the labor market effects of the reforms during the financial crisis, we combine three sources of data: (1) employment and earnings information for individual workers from the annual Census of employees and wages, Quadros de Pessoal (QP); (2) income and balance sheet information for employers from the System of Integrated Accounts (SCIE); (3) collective bargaining agreement information from the Labor Bulletin (Boletim do Trabalho e Emprego, BTE). QP is available from 1986 to 2022, but after 2018 it no longer identifies the collective bargaining contracts that cover workers so we focus our main analysis on the period up to 2018, though we report some data up to 2022. SCIE data are available from 2004 to 2023, so we start in 2005. We use the SCIE data on their own for some purposes, but for our main analysis sample we use a matched QP-SCIE file supplied by the National Statistical Office. We merge these data with information collected from BTE on the collective bargaining provisions affecting workers with different job titles in the retail pharmacy industry.

QP covers all pharmacies in the private sector that employ at least one wage-earner. It reports a variety of firm-level information, including annual sales and the firm's industry and location. It also reports detailed data on every wage earner as of the survey reference week in October, including their gender, age, education, occupation, date of hire, monthly earnings (split into several components), hours of work (normal and overtime), and (up to 2018) the collective bargaining contract they are covered by (if any) and their job title under that contract, which determines their wage floor.[19]

We use the SCIE data for information on the number of retail pharmacies in each year, the number of employees at each firm, the legal form of organization of each firm, and annual sales and annual Value Added (VA). VA is defined as the market value of output minus the

[19] The data for QP that are reported to the Labor Ministry are also posted inside the premises of the firm, so that workers and their representatives can check their accuracy. This requirement was designed to reduce misreporting and under-reporting.

costs of intermediate goods and services, after all production taxes have been paid and all production subsidies have been received, i.e. what remains to be distributed among the production factors.

From BTE we extracted information for collective bargaining agreements (CBA's) negotiated from 2005 to 2024 between the National Association of Pharmacies (NAP) and the Pharmacists' Trade Union, and between NAP and the union representing pharmacy technicians. For each CBA we extracted the starting date of the agreement, its expiration date, and data on the worker categories and associated wage floors specified in the contract. We also collected some information on other features of the contract, such as rules governing working time and overtime pay. We matched the contract information and wage floors from BTE to workers in QP, using information on which collective bargaining agreement a worker is covered by, and their wage floor category.

b. Derivation of Analysis Sample

We start by identifying pharmacists working in community pharmacies in mainland Portugal in QP. Pharmacies are reported under NACE-rev2 code 47730. People working as pharmacists are identified by their 4-digit International Standard Classification of Occupation (ISCO) code. We use ISCO-88 code 2224 to identify "pharmacists" until 2009, and ISCO-08 code 2262 from 2010 onwards.

We retain one yearly observation on each individual, dropping the very small number of observations on a second job or overlapping job reported in QP. We then fill in missing information on time-invariant variables using data reported in other years, and re-code gender, year of birth, education (allowing increases) and the starting year at each employer to be consistent over time. We keep worker-year observations for years in which a worker is between 23 and 64 years of age; we also drop a few observations with missing gender or a missing date of hire. We Winsorize monthly wages at the 1st percentile and at 3x the 99th percentile.

Finally, we exclude pharmacists who are owners or part owners of their firm (14% of pharmacists) since their earnings are not reported in QP (though we include these people in the total count of pharmacists at each firm). We drop a very small number of pharmacists who are

unpaid family members of the owner, or members of cooperatives. For our main analysis sample, which only runs to 2018, we also eliminate pharmacists who are covered by a collective bargaining agreement other than the agreements for either pharmacists or pharmacy technicians. As explained below, in some cases we see people whose occupation in a given year is "pharmacist" but who are reported in QP as being covered by the collective bargaining agreement for pharmacy technicians, with a job title defining their wage floor category as pharmacy technician. We interpret these workers as having being "downgraded" to a pharmacy technician position to reduce the firm's payroll costs.

As noted, we assign the wage floors from BTE to workers in QP. We only assign wage floors to full time workers who are covered by a CBA. QP reports each worker's base monthly wage, as well as a total monthly wage that includes regularly paid supplements (like meal allowances) and irregular supplements or premiums like overtime pay that were paid during the survey month. Following Card and Cardoso (2022) we define a worker's "base wage cushion" as the log of the ratio of their monthly real base wage to their real wage floor. This is the percentage gap between their base wage and their wage floor. Similarly, we define a worker's "total wage cushion" as the log of the ratio of their monthly real total wage to their real wage floor.

c. Descriptive Statistics

Table 1 presents an overview of the data set combining information from QP, SCIE, and BTE, with data for every 4th year of the sample. Beginning in the upper panel, we report the number of community pharmacies in the country, including the number of pharmacies reported by the Portuguese statistical agency (INE) and the number of firms with an industry code corresponding to "retail pharmacy" in SCIE. The latter includes outlets that sell health supplements and related products but no prescription drugs, leading to a 25% over-count relative to INE. Unfortunately, a finer industry code that would allow us to eliminate these outlets is not available. Keeping that in mind, we note that the log of total real sales of pharmacy firms in the SCIE data set rose slightly between 2005 and 2009, then fell 32% between 2009 and 2014, and recovered only partly by 2018.

Next we show some information on pharmacies included in QP, which has an industry classification closer to the INE definition but excludes firms with no wage-earning employees. About 95% of pharmacies counted by INE appear in QP, but only about 70% of all the pharmacies in QP end up being included in our Analysis Sample. In particular we lose pharmacies where the only pharmacist is an owner or part owner.[20] Just before the financial crisis the firms in our Analysis Sample accounted for 77% if sales in the pharmacy industry (as defined by SCIE); this fraction rose to 85% by 2018.

The lower panel of Table 1 presents some information on the pharmacists included in our Analysis Sample. On average we have 2.4 wage earning pharmacists per pharmacy, but the ratio rises from 1.67 in 2005 to 3.25 in 2022. This reflects the fact that despite the slow growth in the total number of pharmacies in Portugal, the number of pharmacists in the retail pharmacy sector grew relatively rapidly. It also reflects the shift in ownership patterns (noted in Appendix Figure 1) away from sole proprietorships, which are more likely to have only a single pharmacist in the firm who is also the owner.

Appendix Table 2 presents data on the total number of registered pharmacists in Portugal in each year from 2005 to 2022, as well as the number working in retail pharmacies (as reported by INE), the total number recorded in QP, and the total number in our Analysis Sample. We note that the share of all registered pharmacists in the country working in retail pharmacy grew between 2005 and 2009; was relatively stable at just over 70% between 2009 and 2018; then drifted down slightly in the early 2020s.

Looking at the characteristics of pharmacists in our Analysis Sample we see that 81% are female and that around 90% work full time. Pharmacists are also relatively young and have relatively few years on their current job, reflecting the rapid growth of the profession. The typical total monthly wage of pharmacists was around €2,100 per month in 2005, but fell to around €1,600 by 2018, consistent with the pattern in Figure 1. On average pharmacists covered by collective bargains earn a monthly base wage that is about 10% above their wage floor, and a total monthly wage that is about 20% above their base wage.

[20] Appendix Table 1 shows the numbers of retail pharmacies by year in INE, SCIE, and in QP, with various restrictions on the QP sample.

V. Productivity and Wages of Pharmacists Before and After the Financial Crisis

a. Value Added per Worker in the Pharmacy Industry

We begin our analysis by examining industry-wide trends in value added per pharmacist and per worker in the retail pharmacy sector. Value added (VA) is directly reported in SCIE for all pharmacies that are organized as Incorporated Businesses. For sole proprietorships, however, we only have information on sales. We therefore impute VA using a simple regression model, fit to annual data for pharmacies with both sales and VA data. Specifically we regress log real value added of a given firm in a given year on log real sales of the firm, the number of employees of the firm, and the interaction between sales and number of employees. This regression has an R-squared of 0.88. We then use the model to impute VA at any firm with missing VA data, and construct the ratio of VA to the number of workers at the firm and to the number of pharmacists at the firm.

We construct 4 measures of aggregate annual VA per worker for firms in our Analysis Sample using 2 alternative ways to count workers – by the number of pharmacists or by the total number of all workers.[21] Let VA_{jt} denote value added at firm j in year t and let N_{jt} represent the number of workers at that firm. Then for a given way of counting workers we compare

$$\rho_t^1 = \log(\frac{\sum_j VA_{jt}}{\sum_j N_{jt}}) \quad \text{and} \quad \rho_t^2 = \sum_j n_{jt} \log(\frac{VA_{jt}}{N_{jt}}),$$

where N_{jt} is the number of pharmacists at firm j in year t. ρ_t^1 is a standard measure of industry-average productivity, while ρ_t^2 incorporates heterogeneity across firms, with a weight that summarizes the average impact on pharmacists. In our data ρ_t^1 and ρ_t^2 are very similar whether we measure employment by all workers or just pharmacists. Deviations of the four alternative measures from their 2009 level are plotted in Figure 2.

The four value measures all move together in the 2009-2012 period of reforms, showing a rapid decline in productivity of around 35 ppt. In the years from 2012 to 2016, value added per worker rose by around 10 ppt., while value added per pharmacist was stable. This

[21] For the calculations of VA per worker we consider all pharmacists who work at the firms in our Analysis Sample, including owners, even though owners are excluded from the worker analysis sample.

discrepancy reflects a divergence in the growth of numbers of pharmacists and non-pharmacists: from 2012 to 2016 the number of pharmacists working at community pharmacies increased by around 20% while the total workforce only rose by 6% (implying a small net decline in non-pharmacist employment in the industry). After 2016, the numbers of pharmacists and non-pharmacists grew at a similar pace, and value added per worker and value added per pharmacist resumed their parallel trends, with net growth between 2016 and 2022 of around 8-10 percentage points.

b. Collective Bargaining Negotiations

The collective bargaining agreement between the National Association of Pharmacies and the Pharmacists' Union was renegotiated every second year between 2006 and 2018. Table 2 presents an overview of the main features of this contract as of 2005, together with a summary of the major changes at each renegotiation. Prior to the upheavals caused by the financial crisis, the pharmacist's CBA had 4 separate wage floors for registered pharmacists in their first, second, third, and fourth and higher years on the job, and a fifth category for the Technical Director of each pharmacy. The contract as of 2005 prescribed 40 hours per week for a full-time job, with premiums for overtime and evening and weekend work. Renegotiations in 2006 and 2008 had only minor effects on the main features of the CBA but increased the wage floors by 3% or 4%, with larger increases for the Technical Director position.

The 2010 agreement, which was negotiated against a backdrop of significant losses in pharmacies' revenues, introduced a new set of wage floor categories, with five new titles replacing the five existing titles. Although the floors under the new system were set slightly above the floors under the old system, it appears that some pharmacies used this opportunity to re-shuffle employees to lower floors, with the net effect being a reduction in the average wages of pharmacists (see below). In addition, the contract replaced the previous overtime system with an "hours bank" that could be used to accumulate overtime hours, albeit with no associated premium.

The 2012 contract introduced three further changes: (1) a lower-tier of wage floors for newly hired pharmacists, with a 6th and substantially lower floor for the least senior workers;

(2) a slowdown in the pace of promotions between floors; (3) a provision that workers hired before 2012 could move to the lower tier wage schedule in exchange for some extra holidays. The impact of the first two changes is illustrated in Figure 3, where we show the time paths of the wage floors affecting different cohorts of newly hired pharmacists. Up until the cohort entering the profession in 2010, pharmacists were promoted after 1 year in each floor, achieving roughly 27% wage growth in their first 4 years (ignoring any change in their wage cushions). Cohorts entering in 2012 and beyond started on the new floor for entry workers (set 25% below the previously lowest floor), then progressed to a series of floors set 10% below the previous grid, but at a much slower pace. As a consequence, a newly graduated pharmacist who entered the retail pharmacy sector in 2012 and earned a wage equal to the sectoral floor would earn about 30% less over their first 5 years than if they had entered two years earlier. The same is true for pharmacists who had to move to a new job because their previous employer went out of business or reduced its workforce.

The 2014 contract extended the 2012 agreement, with no major updates or increases in the wage floors. The 2016 contract further slowed the pace of promotions between wage categories, requiring 4 years in each level (versus 1 year per level prior to 2012, 2 years per level in 2012 and 2013, and 3 years per level in 2014-2015). It also introduced a set of bonuses payable to lower tier workers linked to worker performance. Unfortunately, the timing of the bonus payments does not coincide with the QP survey period so we have no information on the size of these bonuses.

The 2018 contract returned to a more "business as usual" format, with small increases in the wage floors but no other major changes. No new contract was negotiated over the following 6 years. In 2024, however, a new agreement was reached that raised the wage floors in general by 4.5%, and the wage floor for the entry category by 13%. It also further slowed the pace of promotion between floor categories for workers on the lower tier.

c. Average Wage Outcomes 2009-2018

Figure 4 presents a graphical summary of the evolution of average base wages for pharmacists in our QP Analysis Sample over the period from 2009 to 2018 (after which we can

no longer assign wage floors). Since wages are much different for workers who were in the industry before 2012 and those who entered later, we begin in Panel A by showing the share of all pharmacists hired at their current firm in 2012 or later. This rises very quickly, reaching just over 60% by 2018. The rapid rise is a consequence of two factors: steady inflows of new graduates (accounting for 5-6% per year increases in the workforce in the years from 2012 to 2016, and 3-5% in later years), and job churn (accounting for another 5-6% per year of employment) caused by the closing or downsizing of older firms.

Panel B shows the mean base wages of pharmacists working under the older tier of wages and the new lower tier of wages. Notice first that real base wages of workers paid under the older tier fell by about 10% between 2009 and 2012. Some of this decline was due to inflation: prices rose by 7.9% over these 3 years while nominal wage floors were only raised by 1.3%. In addition there was some reduction in the mean real wage floors of these workers, driven by reshuffling of workers to lower floors.[22] When the lower tier was introduced in 2012, the gap in mean log wages between the lower and upper tiers was around 40 log points, reflecting the large gap in wage floors between entering workers and incumbent workers illustrated in Figure 3, as well as differences in mean wage cushions for the two groups. The gap closed slightly by 2018, driven by growth in wage floors for people hired between 2012 and 2017 and some adjustment of the wage cushions.

Finally, Panel C illustrates how the rising share of lower-tier workers and their much lower average wages led to the remarkable decline in mean wages for all workers in the pharmacy sector documented in Figure 1. Note that if we decompose the mean log base wage in 2018 ($\overline{w}_{2018}$) into a weighted average of base wages for upper and lower tier workers:

$$\overline{w}_{2018} = 0.37\overline{w}_{2018}^{upper} + 0.63\overline{w}_{2018}^{lower},$$

then the change in mean log wages between 2009 and 2018 can be written as:

[22] One possibility is that firms moved qualified pharmacists to pharmacy technician jobs to save money. We conducted a simple analysis of job-title transitions between these two sets of jobs– see Appendix Table 3. We see relatively large numbers of "demotions" from pharmacist to pharmacy technician in 2010, 2012, and 2016, and a more consistent rate of "promotion" from pharmacy technician to pharmacist. When we look at the changes in base wage rates for the movers, however, we see relatively small changes for movers in both directions, suggesting that many of the demotions and promotions may reflect mis-coding of job titles. For example, in 2010 about 11% of workers recorded as working as a pharmacist in the previous year were recorded as working as a pharmacy technician, yet the mean change in log base wages for the movers was very close to 0.

$$\bar{w}_{2018} - \bar{w}_{2009} = 0.37\left(\bar{w}_{2018}^{upper} - \bar{w}_{2009}\right) + 0.63\left(\bar{w}_{2018}^{lower} - \bar{w}_{2009}\right).$$

Since $\bar{w}_{2018}^{upper} - \bar{w}_{2009} \approx -0.11$ and $\bar{w}_{2018}^{lower} - \bar{w}_{2009} \approx -0.47$, this equation suggests that 88% (=0.63x0.47/0.34) of the reduction in average wages between 2009 and 2018 was attributable to the hiring of workers under the lower tier wage schedule.

The results in Figure 4 pertain to real base wages. How different is the story if we look at total wages, including premiums and supplements? Appendix Figure 3 shows the paths of the average wage floor, the average base wage, and the average total wage for pharmacists as a whole, without distinguishing between upper and lower tier workers. While the three series do not move exactly in parallel, looking at the overall declines between 2009 and 2018 we conclude that base wages and total wages responded very similarly to the massive loss in value added per worker in the sector.

d. Mean Wages of Pharmacists by Firm Tenure

So far we have focused on wages of pharmacists using data from QP that allows us to determine their collectively bargained wage floors. As noted, the information in QP regarding collective bargaining coverage stops in 2018. To extend the analysis in Figure 4 and check the robustness of our conclusions about pharmacists' wages to our use of the QP analysis sample, we constructed an alternative sample by keeping all full-time wage-earner pharmacists working in community pharmacies (as in the main analysis sample), but imposing no condition on the job category or the availability of wage floor information. We then constructed mean log base wages and total wages by years of tenure at the current employer. The results are results are reported in Figure 5, with data on base wages in panel a and data on total wages in panel b of the figure.

For newly hired workers (with tenure ≤1 year) whose wages would reflect the switch to the lower tier wage schedule after 2012, we see a 50 log point drop in mean base and total wages between 2009 and 2014, with a modest recovery thereafter. For the longest-tenure group (≥16 years), whose wages would be set by the upper tier wage schedule in all years of the sample, we see a 16 log point drop in mean base wages and total wages between 2009 and 2014 (slightly larger than the 11 log point drop in mean base wages for workers covered by the

upper tier schedule in our main analysis sample shown in Figure 4a) followed by relative stability until 2021. Real wages of all tenure groups fell sharply in 2022, reflecting the 8 percent inflation rate in that year that was far above expectations.

e. Wages of Other Pharmacy Workers

We have shown that wages of pharmacists fell in response to the negative shock in profitability of community pharmacies. What happened to the wages of other pharmacy workers? As we noted, pharmacists represent about one third of the workforce at a typical pharmacy: other workers, including pharmacy technicians, clerical workers, and cleaning staff account for around two thirds of employment. Appendix Figure 4 shows mean log total wages for pharmacists and non-pharmacists employed at community pharmacies between 2008 and 2022. Consistent with the data we have seen so far, mean real wages of pharmacists fell relatively rapidly between 2009 and 2012 (by about 21%), but continued to decline until 2018 or so, ending up about 37% lower in 2022 than 2009. The real wages of other workers fell also fell rapidly between 2009 and 2012, by about the same percentage as pharmacists (24%), but then stabilized, ending up 24% lower in 2022 than 2009. The decline in real wages of other workers from 2009 to 2012 came about through a combination of inflation (about one-third of the total) and reductions in nominal base wages. Interestingly however, there was not any differential fall for newly hired workers – contrary to the remarkable pattern for pharmacists.

Combining data for pharmacists and non-pharmacists, we estimate that the real wage bill of a typical pharmacy fell by about 23% between 2009 and 2012, and a further 6 ppts between 2012 and 2022. Over this period the relative share of pharmacists in total employment rose, and their share of the wage bill also increased (from 28% to 36%). Using an average share of around one-third, we infer that pharmacists wage cuts accounted for about 45% of the total reduction in the real wage bill of pharmacists between 2009 and 2022.

VI. Responses of Wages to Firm-Specific Productivity

Looking at the productivity and wage changes in Figure 1 (and the related data in Figures 2-4), the implied elasticity of average pharmacist wages with respect to value added per

worker in the industry is around 1. This is higher than nearly all existing estimates of the pass-through from productivity to wages in the "rent sharing" literature, which are typically closer to 0.1 (Card et al. 2018).[23]

Importantly, Figures 1-4 compare *industry-wide* changes in productivity and wages, while the target parameter in most rent-sharing studies is the elasticity of wages with respect to *firm-specific* productivity shocks, holding constant conditions at other firms in the industry.[24] Card et al. (2018) interpret this parameter as a transformation of the firm-specific labor supply elasticity in a monopsonistically competitive model of wage setting; many earlier papers interpret it in terms of a bargaining model (see e.g., Card et al. 2014). In either class of models, the effect of an industry-wide shock on wages may differ from the effect of a firm-specific shock, as illustrated in the model developed by Carlsson et al. (2016). Indeed, even in a perfectly competitive model of wage setting, an industry-level shock can affect wages if the supply of workers to the industry is wage elastic, though in such a model wages and employment move along a positively sloped industry supply curve, rather than in opposite direction as happened in our setting.

Despite the fact that standard models linking wages to firm-specific productivity differences do not necessarily tell us how wages will react to industry-wide shocks, it is interesting to ask what the estimates from such models look like in our setting. The answer is provided in Table 3, where we fit simple models relating the log wage of a pharmacist working at a given firm in a given year to characteristics of the pharmacist (gender, education, age, tenure at the firm), a set of year effects, and value added per pharmacist at the firm. To address the effects of the two-tier wage contract in place after 2012 we include a dummy indicating whether the worker was hired under the terms of the lower tier (post-2012) wage contract. We also include a variable representing the log of the share of all workers at a given retail

[23] An exception is the 0.5 elasticity estimate reported by Kline et al. (2019), which is based on wage responses to the filing of significant patent applications in the U.S.

[24] In cases where the firm in question accounts for a small share of industry output, it is plausible that an idiosyncratic productivity shock could leave productivity unchanged at other firms in the industry. In other situations, however, a positive productivity shock at one firm could lead to negative shocks for its competitors. What is being held constant at other firms in the data generating process specifying the target parameter is therefore somewhat fuzzy.

pharmacy who are employed as pharmacists (and its firm-average value) to control for firm-specific differences in workforce composition. With the inclusion of these variables the estimated effects of value added per worker are invariant to whether we measure workers by the total number of employees at the firm or the number of pharmacists.

We present two specifications for each wage measure. The first includes only the control variables, while the second includes the log of value added per pharmacist at the firm in the current year and the average value of this variable across all years that the firm is in the sample. This correlated random effects specification separately identifies the responses of wages to the within-firm and between-firm components of productivity differences. The estimated coefficient on value added in the current year is numerically identical to the coefficient that would be obtained in model with firm fixed effects (Wooldridge, 2019), and arguably represents the response of wages to short term fluctuations in value added. The estimated coefficient on average value added at the firm, on the other hand, arguably captures longer run adjustments of wages to productivity, as well as other differences between more and less profitable firms that are correlated with wages.

Columns 1-2 present estimates where the dependent variable is the pharmacist's wage floor. As might be expected in a setting with sectorally-determined floors, these floors are only weakly related to firm-specific productivity, though they are about 12 percent lower for people hired under the post-2012 wage schedule, controlling for tenure and other characteristics.[25] Columns 3-4 present estimates of the same specifications using the base wage as the dependent variable, while columns 5-6 present models for the total wage. Base wages and total wages are positively correlated with both the current level of productivity and the average level of productivity at the firm, with elasticities of around 5 percent. These estimates are broadly consistent with the estimates in the literature surveyed by Card et al. (2018), which generally finds elasticities of 0.1 or less from specifications with firm fixed effects. We also find that base and total wages are 18-20 percent lower for workers hired after 2012 under the lower tier wage floor.

[25] As discussed in relation to Table 2 and Figure 3, the lower tier wage floors were set 10% below than the standard tier schedules, but post-2012 hires were started at a new lower wage floor category 24% below the previous entry floor.

Though not reported in the table, all of the individual characteristics of pharmacists included in the models have reasonable effects on wages. Most interestingly, the estimated effect of female gender is essentially 0 for base wages (point estimate = −0.003, standard error = 0.003), but negative for total wages (point estimate = −0.019, standard error = 0.003).[26] The small gender penalty in total wages may be due to differences in work schedules and overtime between women and men that affect total pay but not base pay.

Overall, we conclude that the responsiveness of wages to firm-specific shocks in the Portuguese community pharmacy sector is very similar to the reactions measured in most other studies in the existing literature, despite some unusual features of the sector, like the high level of regulation of firm entry and pricing.[27] The reaction to the industry-wide shock from the reforms during financial crisis, however, is an order of magnitude larger. Moreover, the cut in wages following the shock to pharmacies' profitability was accompanied by a rise in pharmacist employment, rather than a reduction. These patterns lead us to turn to a longer-term perspective on wages and employment changes in the industry.

VII. Comparisons: Pharmacists versus Other Professions

One important question for understanding the longer-run implications of the wage cuts for pharmacists documented so far is whether pharmacists' wages in the pre-crisis period contained substantial rents. If they did, it is conceivable that people would still be willing to enter the industry even with much lower wages. A related question is how wages for pharmacists evolved in the post-crisis period relative to wages for similarly educated workers in other sectors, since previous research has shown that the average wages of highly educated workers in Portugal fell in the 2010's (e.g., Card and Cardoso, 2022).

To address these questions we began by analyzing data on university applicants to identify which specific alternative programs the applicants to pharmacy programs also apply to. Following Murphy and Silva (2026), we use data on the universe of applicants to university

[26] By comparison, Goldin and Katz (2016, Table 3) estimate that the hourly wage penalty for female pharmacists in the US is around 5%.

[27] It also has a high rate of collective bargaining coverage, though this is also true of many other studies of rent sharing, which focus on unionized workers.

degree programs in Portugal from 2013 to 2023. Students submit a ranked list of programs that receive their application data, including scores on national end-of-high school exams.[28] Using these ranked lists we then identified the most common other programs that applicants to the integrated masters of pharmacy (MICF) programs also apply to. Among options ranked more highly than the first MICF on an applicant's list (i.e., "reach" options for pharmacy applicants), the most common are programs leading to a doctor of medicine (MD); among options ranked just below MICF programs (i.e., "safety" options) the most common are biochemistry and nursing (RN) programs.[29] Based on these rankings, and the content of the programs, we believe that medicine and nursing are very plausible alternative careers for applicants to pharmacy programs.[30] Existing data do not allow us to identify the specific occupations pursued by graduates from biochemistry programs in Portugal so we focus on MD's and RN's.

We use QP data for Portugal and data from the American Community Survey (ACS) for the US to compare mean wages in Portugal versus the U.S. for each of the three professional groups: pharmacists, MD's and RN's. Since wages are only reported in QP for wage earners, we follow the same approach in the ACS and exclude self-employed workers. This means in the case of MD's that we are probably excluding many of the most highly paid physicians who specialize in fields like surgery. To address differences in the share of part time workers we use data on full time workers for Portugal; we include full and part time workers in the U.S. but our results are very similar if we use only full-time workers in the U.S. too. We convert total monthly wages in QP to an annual salary basis and measure total annual wage and salary income in ACS. Figures 6a and 6b plot mean log total annual wages for the three groups between 2008 and 2022 in Portugal and the U.S., respectively.

Focusing first on data for the beginning years of the sample, notice that in Portugal in 2008-2009, pharmacists' wages were about half-way between MD's and nurses, with a 40 log

[28] Applicants apply to specific programs at specific universities, e.g., the MICF program at University of Lisbon.
[29] See Ali and Shorrer (2025) for a discussion of strategies that students adopt when applying to colleges and universities.
[30] Goldin and Katz (2016) compare pharmacists to physicians, lawyers, and veterinarians. We believe the comparison to lawyers is less compelling – there is almost no overlap between applicants to law and pharmacy programs in Portugal. We have examined data for veterinarians, but veterinary medicine is a relatively small field and most veterinarians are self-employed (and thus excluded from QP).

point wage gap between pharmacists and nurses and a similar 40 log point gap between MD's and pharmacists. In the U.S. the wage gap between pharmacists and RN's was about the same in Portugal, but the wage gap between MD's and pharmacists was bigger (around 55 log points). Taking account of the much higher private costs of obtaining a medical degree in the U.S. than Portugal, these simple comparisons suggest that prior to the financial crisis in Portugal pharmacists' relative position in the labor market was broadly similar in Portugal and the U.S.

Over the next 15 years real wages of the two comparison groups were quite stable in Portugal but a little more variable in the U.S., with some rise in MD's wages in the U.S. over the 2015-2018 period that was partly reversed by 2022, and a small decline in wages of RN's. Real wages of pharmacists in the U.S. also trended down somewhat, so that by 2022 the wage gap between pharmacists and RN's in the U.S. had narrowed to around 30 log points. In Portugal, however, real wages of pharmacists declined by 30%. By 2022, the wage gap between pharmacists and RN's was nearly eliminated.

The simple comparisons in Figure 6 suggest that the decline in wages of pharmacists in Portugal after 2009 was highly unusual relative to the situation for doctors or nurses. There was also a small decline in the relative wage of pharmacists in the U.S. relative to the two comparison groups, but that change was less than 1/3 as big as the massive decline in Portugal. We also examined relative wages of pharmacists and RN's in the U.K., using publicly available data on gross hourly pay reported in the Annual Survey of Hours and Employment.[31] In 2009 pharmacists in the U.K. had 27% higher median wages than RN's. By 2022 this ratio had declined slightly to 23%. These data suggest that in the U.K. pharmacists earn a significant wage premium relative to RN's, and that the premium has been relatively stable over the past two decades.

VIII. Long-run Supply Responses

We have noted that despite the decline in wages, the number of pharmacists working in community pharmacies rose relatively quickly in the years after the financial crisis. In this

[31] We have been unable to find similar data for Spain, Italy or Greece.

section we briefly examine the main driver of this rise, which was the inflow of new graduates from Master's programs who were eligible to work as pharmacists.

Figure 7 shows the number of newly graduating students in each year, as a fraction of the total number of registered pharmacists in the year. If all these students were employed, this ratio represents the "inflow rate" of newly qualified pharmacists. In the first 3 years of our sample new graduates were exiting from two-year Masters' programs, which they had entered after completing their bachelors' degrees. By 2008 most of the new graduates were exiting from integrated Master's programs that accepted applicants directly out of high school. This switch was associated with a relatively large increase in the number of new graduates – from around 530 per year in 2005-2007 to just over 800 in 2008 – implying a rise in the inflow rate of new graduates from around 6% per year to 8%. The number of graduates continued to ramp up until 2014, keeping pace with the size of the pharmacist population and maintaining a potential inflow rate of around 8% per year. Starting in 2015, the number of new graduates declined to about 700 or so per year, returning the inflow rate to 6% per year.

To help interpret the magnitude of these inflow rates, suppose that a typical pharmacist graduates at age 28 and works until age 60. If there is no attrition out of the workforce until retirement, an inflow rate of 3% per year will maintain a steady state workforce. Under these conditions an inflow rate of 6% will generate a roughly 3% per year growth in the size of the pharmacist workforce. Consistent with that observation, the total number of registered pharmacists working in Portugal grew by 2.7% per year from 2005 to 2018; the number working in retail pharmacies grew even faster at 4.0% per year.

The data in Figure 7 show some slowdown in the production of new masters' degree holders after 2014 – potentially reflecting a delayed reaction to worsening job prospects for new graduates. The inflow rate only fell below 6% in 2017, however, and even in the early 2020s was still around 4.5% -- more than enough to support continued growth in the size of the pharmacist workforce. This suggests that Portuguese students are still interested in entering Masters' programs to become qualified for a pharmacist career, despite the substantially lower wages that pharmacists now earn relative to the past and relative to other jobs.

A possible concern about the continuing flow of new pharmacists is that they are of lower quality than in the past. To investigate this, we used data from the centralized university admission system in Portugal to look at the high school GPA's of students who either applied to or enrolled in an MICF program between 2013 to 2024. These GPA's are based on all the courses taken in high school that, together with national exams, are used to select students for admission to different university programs. We convert each student's GPA into a percentile within the populations of all applicants and all enrollees, respectively, in a given year. Figure 8 shows the average percentiles of the GPA's of MICF applicants and MICF enrollees over time. (Note that by construction the average percentiles of all applicants and all enrollees are 50 in each year).

The data in Figure 8 suggest that since 2013 (the first year for which we have data), the average ranking of MICF applicants and enrollees have fallen, from just over the 80th percentile to between the 65th and 70th. Students who apply to MICF programs and those who enroll in these programs are still "above average" relative to all applicants and all enrollees, respectively, but their relative quality appears to have declined. It is also interesting that the average percentile of enrollees – which was above the average percentile of applicants for most of the time period – has recently fallen below the average percentile of applicants. This suggests that enrollees are now negatively selected from among all those who apply to pharmacy programs, whereas before they were positively selected, pointing to a decline in the attractiveness of pharmacy programs.

IX. Conclusions

Reforms enacted between 2009 and 2011 led to large reductions in the revenues of retail pharmacists in Portugal, and a dramatic fall in value added per worker. Our analysis suggests that most of the burden of this reform was born by workers, and close to half by pharmacists -- particularly by new hires in the industry. The 2012 collective bargaining agreement between the National Association of Pharmacies and the Pharmacists' Trade Union introduced a lower tier of wages for new hires and slowed the pace of seniority-based pay raises; subsequent agreements reduced the gains to seniority even further. In 2009,

pharmacists with 2-5 years of seniority at their employer earned about 10% less than those with 16 or more years of seniority; by 2016 that gap had widened to 40%. While the relative wages of lower-seniority workers have risen a little since then, it appears that new entrants to the profession can expect to earn substantially less than previous generations of pharmacists in Portugal. The shifting of the burden of the loss in industry profitability to newly entering workers is similar to what occurred in the U.S. auto industry during the Great Recession. Union contracts negotiated in 2007 between the 3 largest American car makers and the autoworkers union introduced a lower tier of wages for new hires that persisted until late 2023 (see Bhattari, 2023 and Chen, 2024).

The fall in wages of newly entering pharmacists occurred against a backdrop of increasing supply of newly qualified pharmacists. Indeed, between 2009 and 2022 the number of pharmacists working in retail pharmacies grew by at least 35%. Data from Portugal's centralized university admission system suggest that many high school students who are applying to integrated masters programs in pharmacy also apply to medicine (as a "reach" option) and nursing (as a "safety" option). Real wages of both comparison groups have been relatively stable over the past two decades. Relative to either alternative, average wages of pharmacists have fallen by about 30 percent. Whether this will ultimately reduce the supply of students willing to enter pharmacy degree programs is unclear: so far, the number of new graduates from these programs remains well above the replacement rate required to maintain a stable workforce in the industry. There is some indication of a reduction in the quality of students applying for pharmacy degrees, but pharmacy program applicants and enrollees are still well above-average in terms of their high school ranks.

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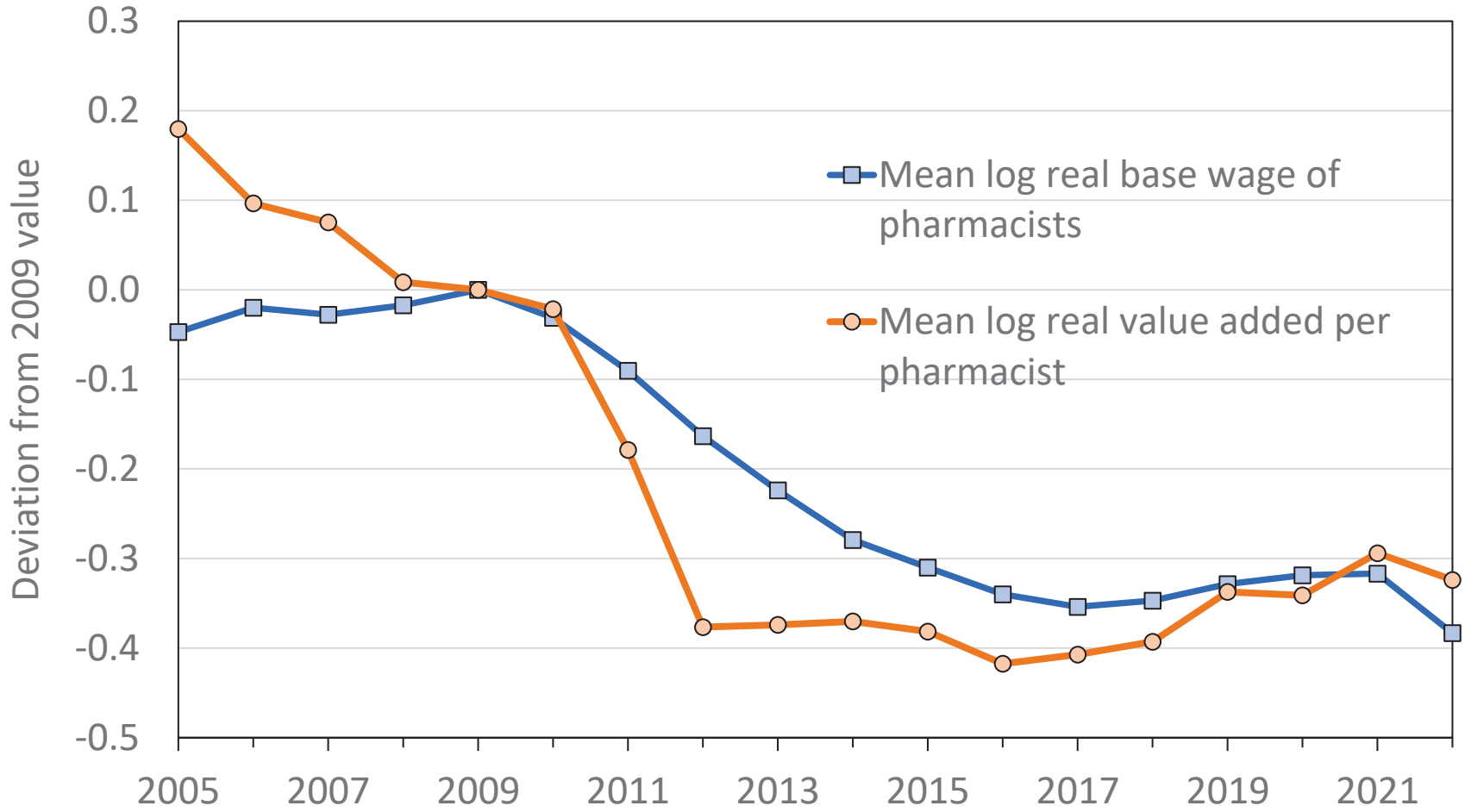
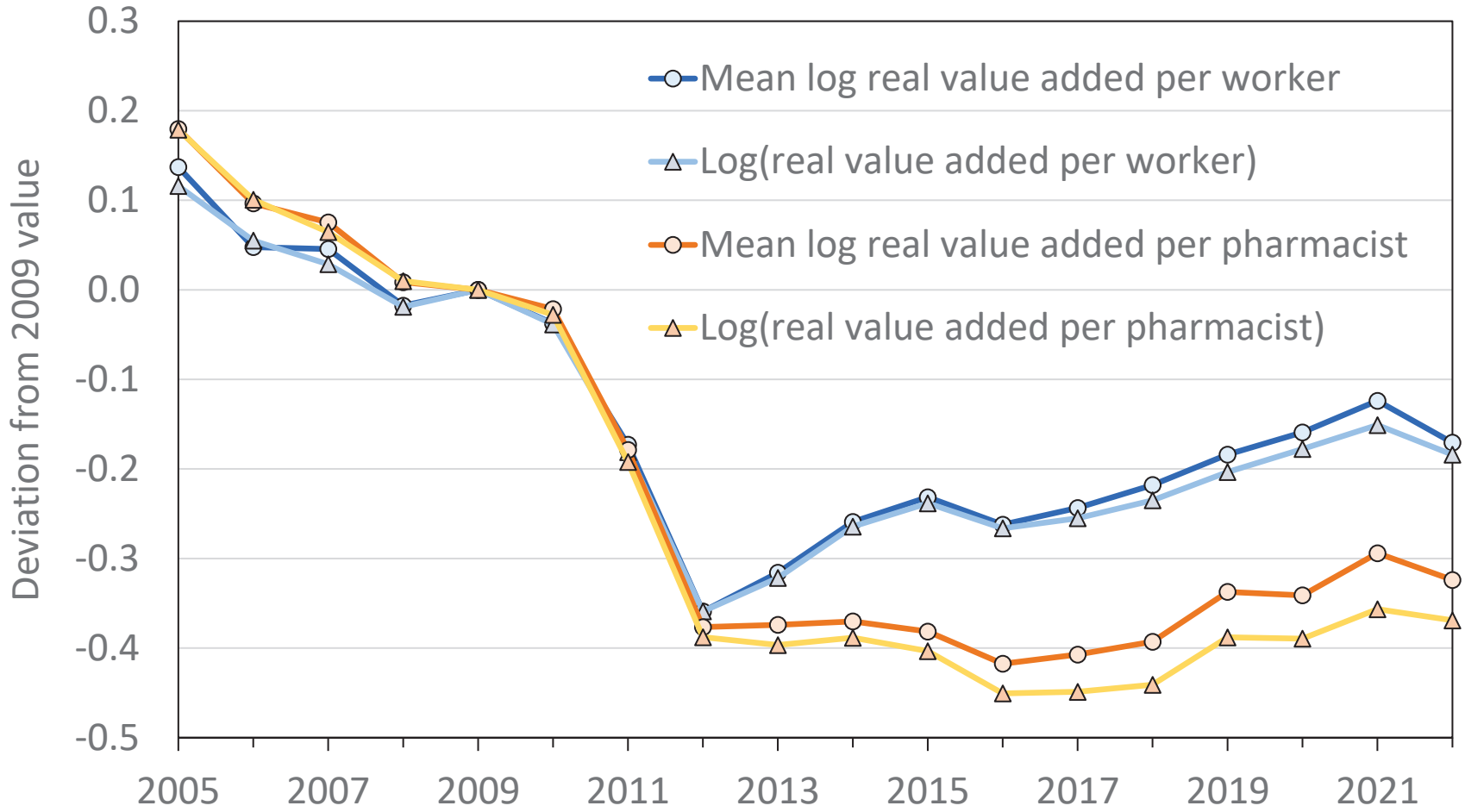
Figure 1: Trends in Value Added per Pharmacist and Average Base Wage of Pharmacists, 2005-22



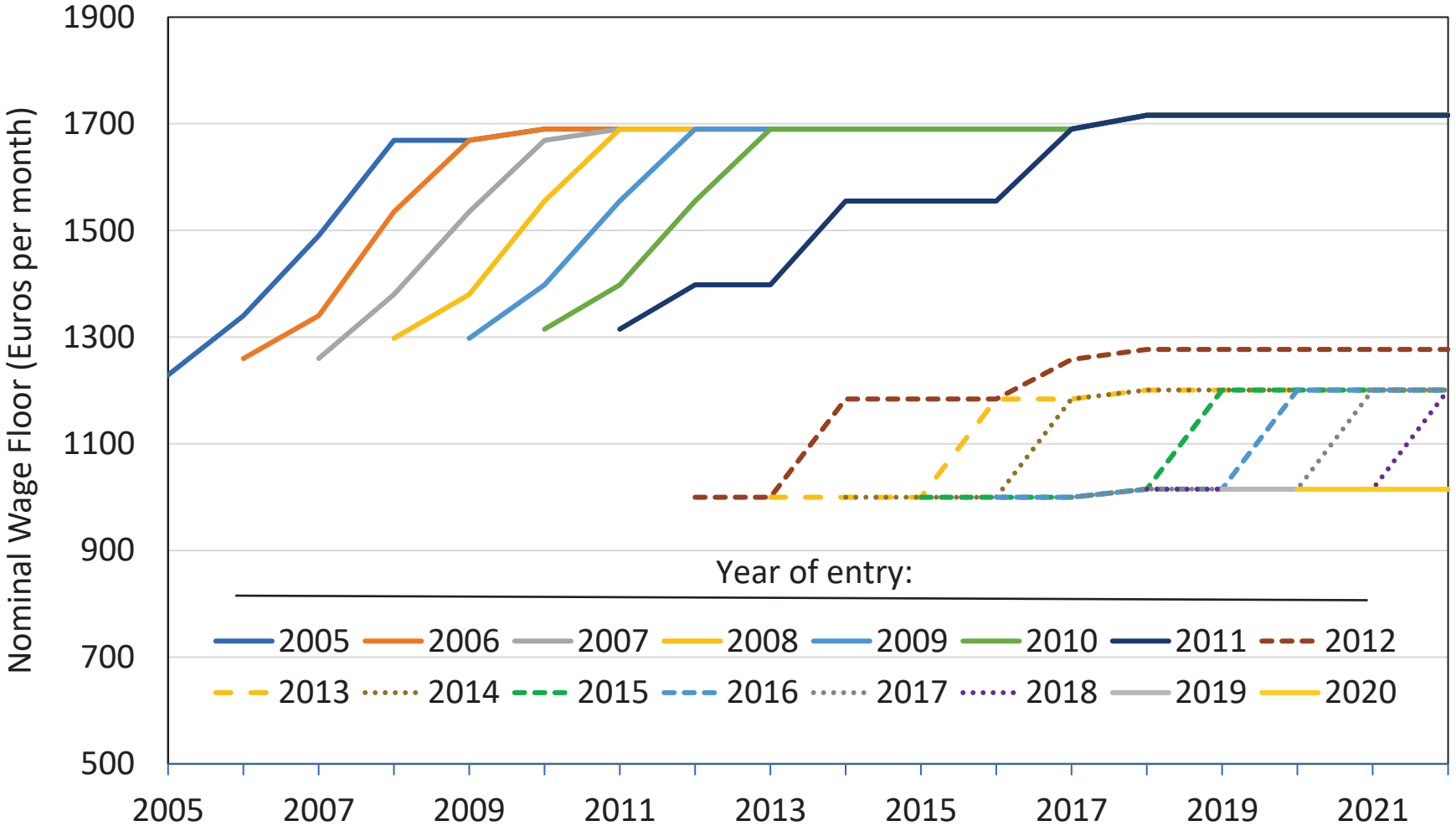
Note : based on QP Analysis Sample of retail pharmacies with at least one paid pharmacist on staff. Wages are calculated for full time workers only.

Figure 2: Trends in Alternative Measures of Value Added per Worker in Pharmacy Industry, 2005-22



Note : based on QP Analysis Sample of retail pharmacies with at least one paid pharmacist on staff. Estimates of mean log value added per pharmacist and per worker are weighted across firms using total number of pharmacists as a weight.

Figure 3: Nominal Wage Floors by Years of Experience for Different Cohorts of Pharmacists, 2005-22



Note: figure shows wage floors for different entry cohorts, assuming individuals in an entry cohort start at the lowest wage floor and progress according to contractual terms.

Figure 4a: Share of Pharmacists on Lower Tier Contracts

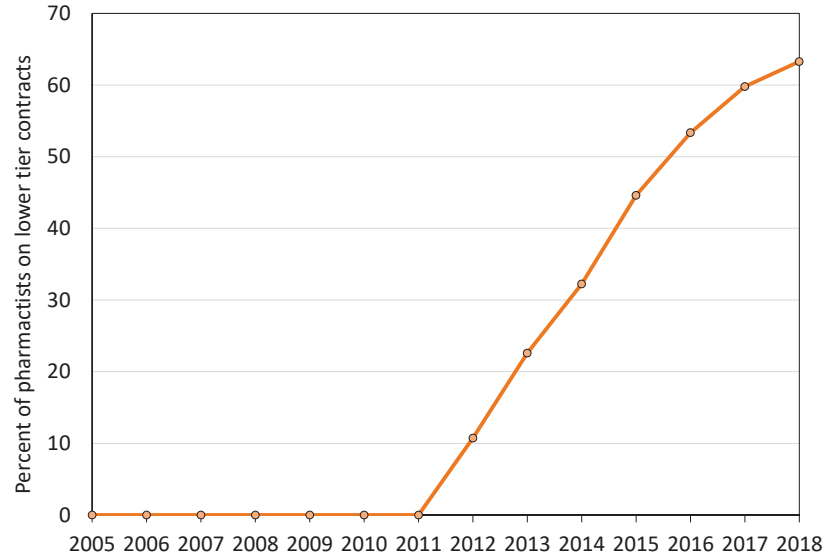


Figure 4b: Mean Log Real Monthly Base Wage by Tier

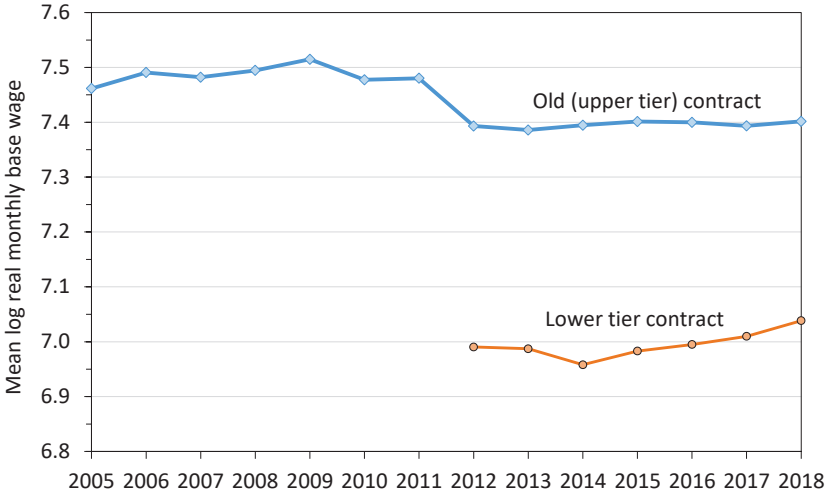


Figure 4c: Evolution of Averge Base Wages -- by Tier and Overall

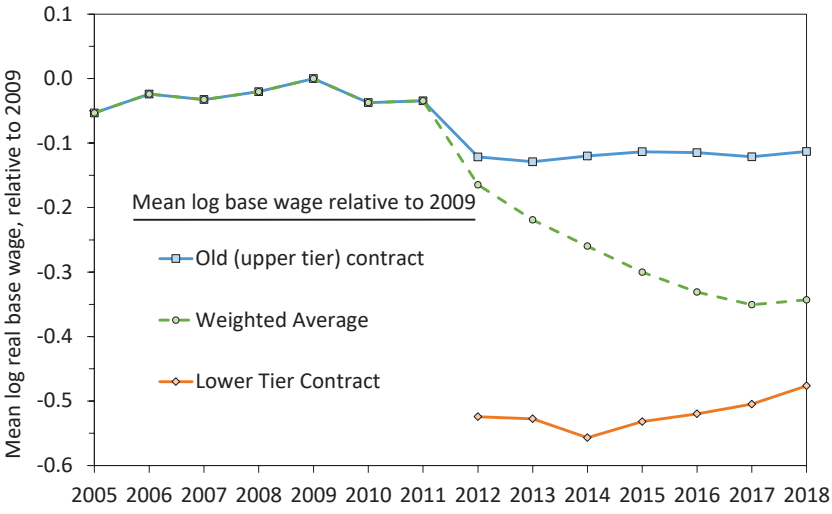


Figure 5a: Mean Log Real Base Wage Rates by Tenure Category

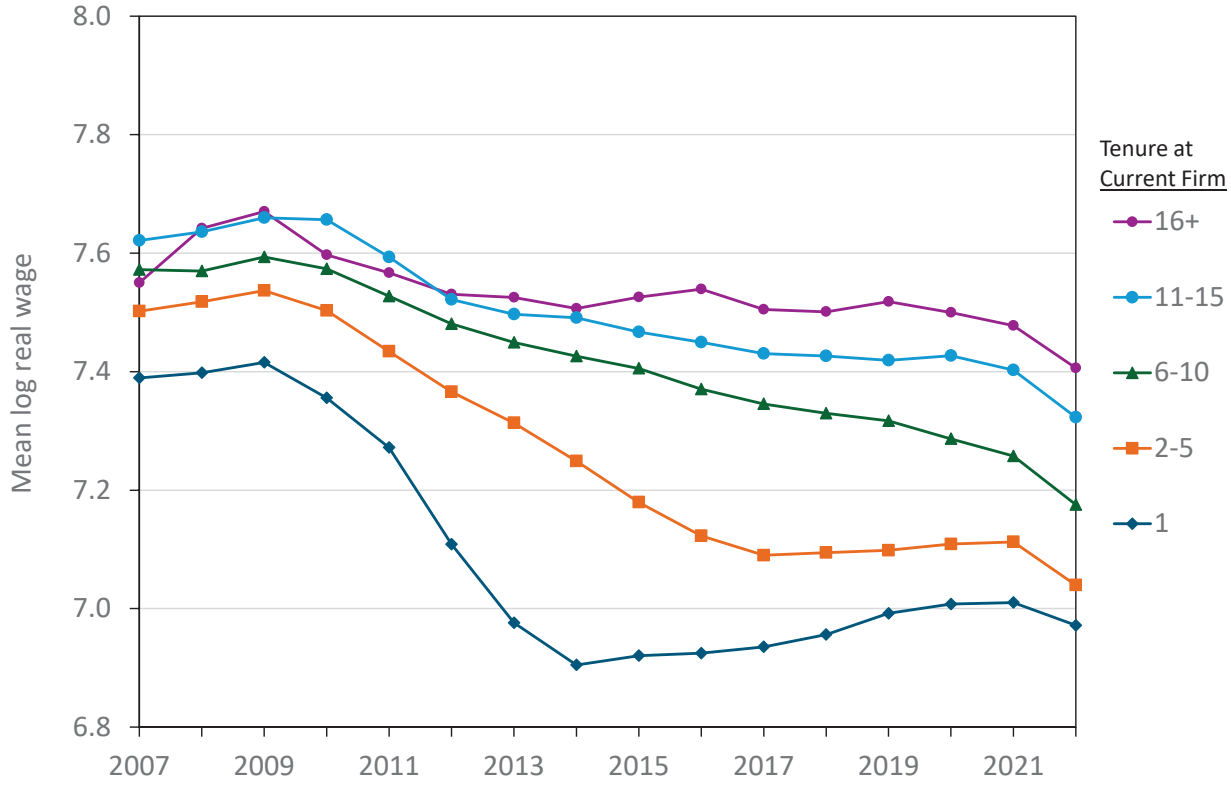


Figure 5b: Mean Log Real Total Wage Rates by Tenure Category

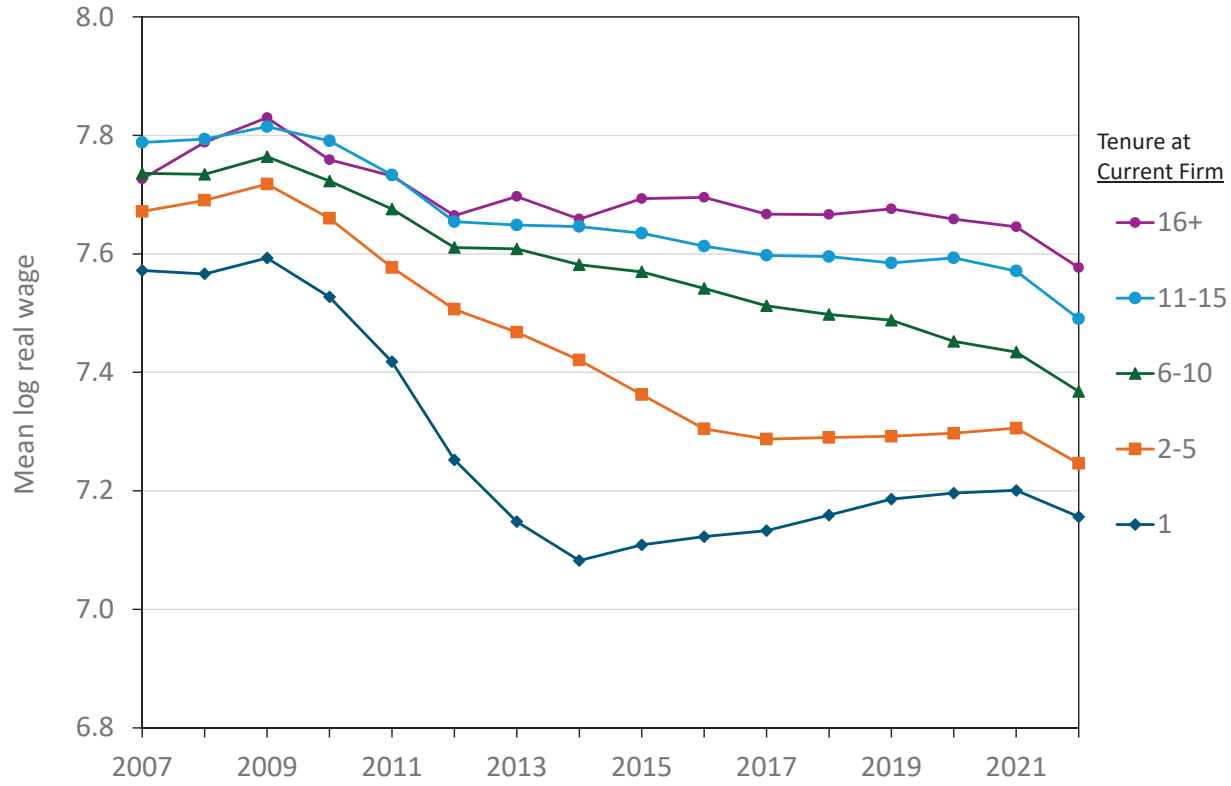


Figure 6a: Mean Log Real Annual Salaries in Portugal

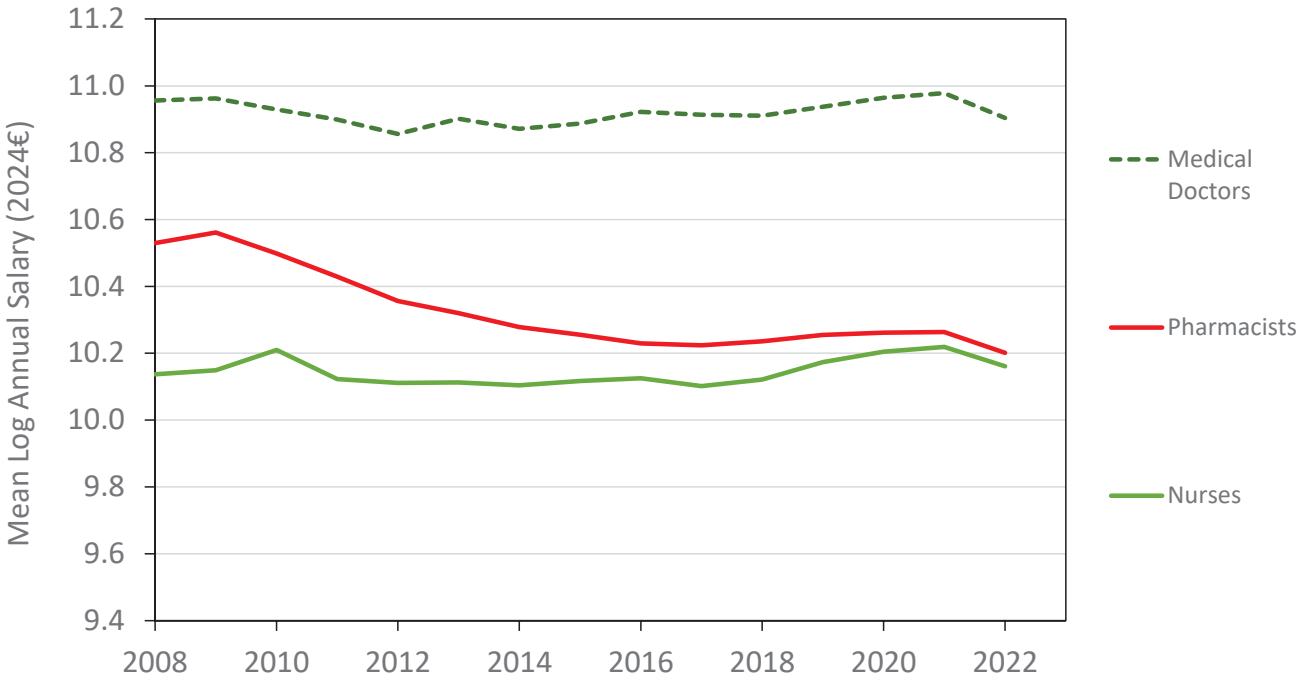


Figure 6b: Mean Log Real Annual Salaries in US

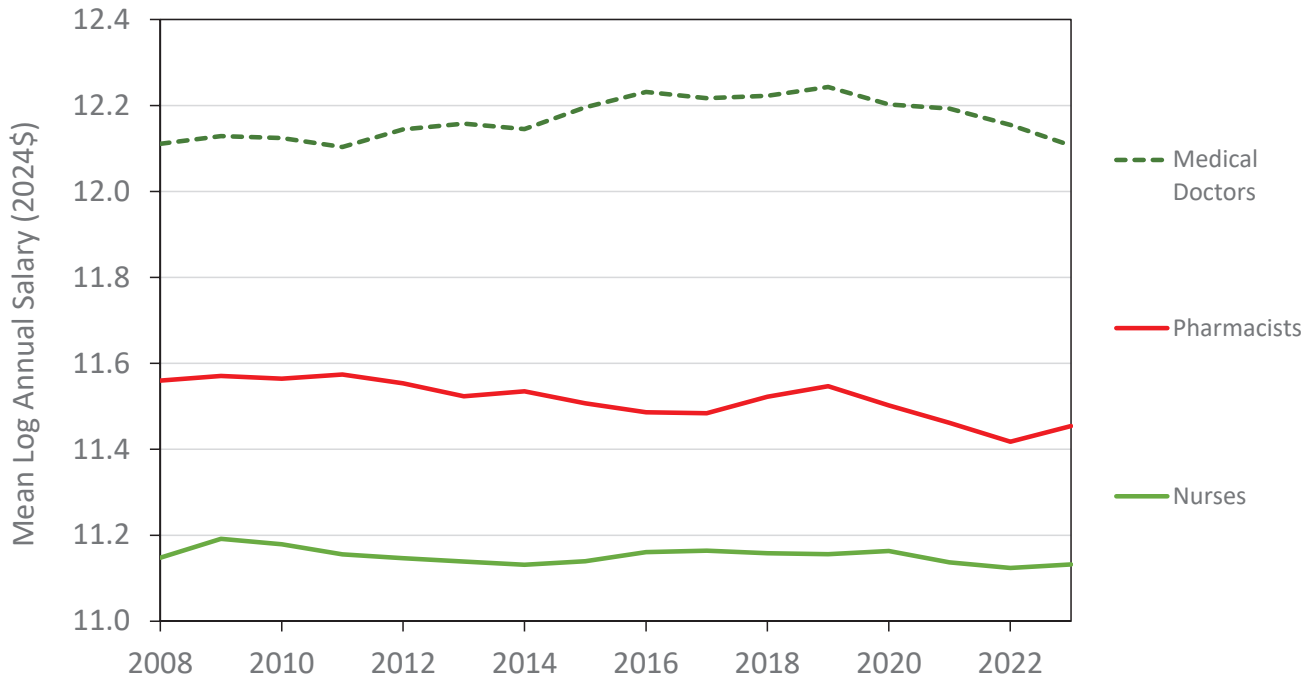
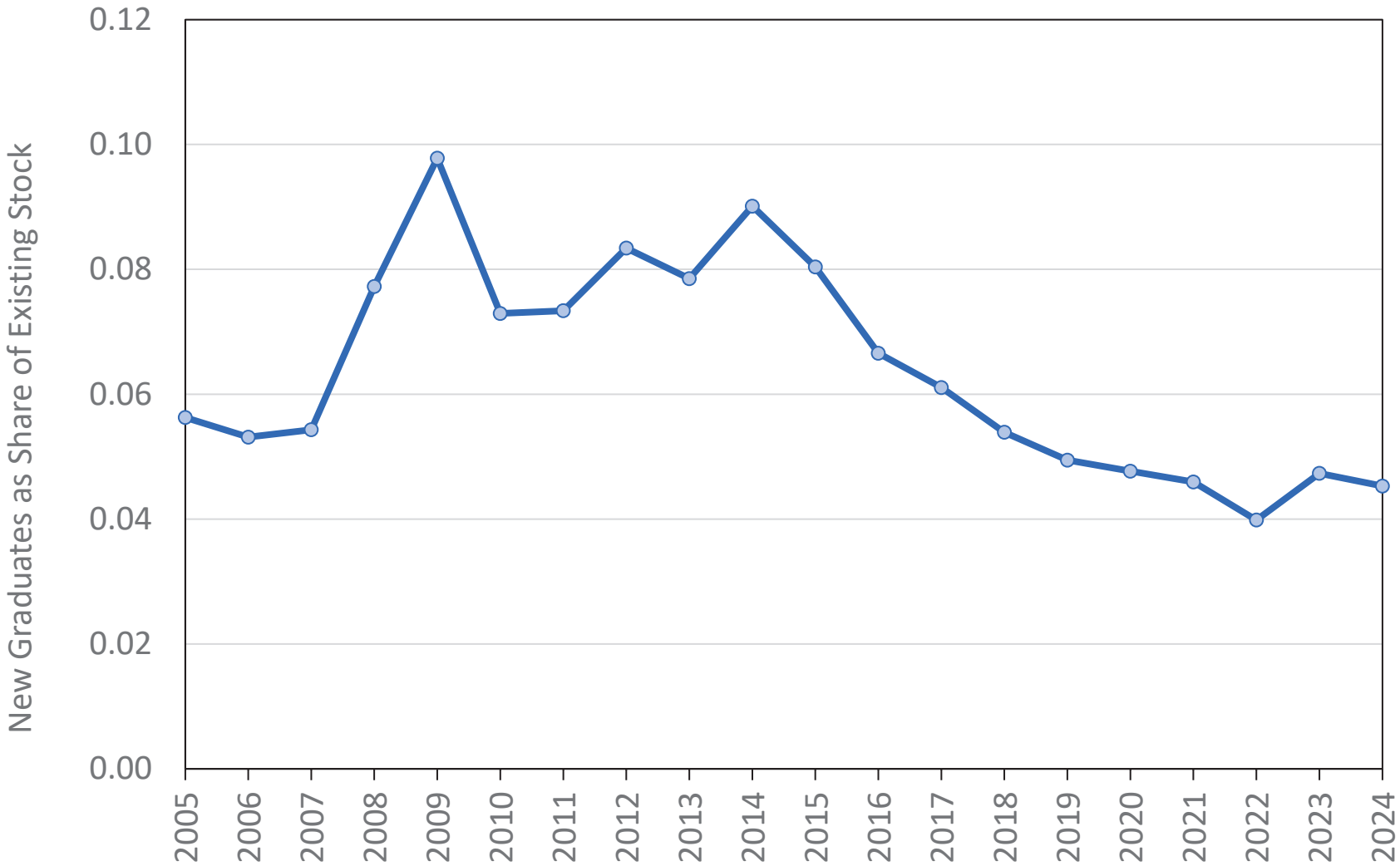


Figure 7: Inflow Rate of Newly Graduating Pharmacists



Note: Inflow rate is calculated as the number of new graduates from Masters programs in Pharmacy Science, divided by the total number of active pharmacists in the same year (as reported by INE).

Figure 8: Mean Percentile of High School GPA's of Pharmacy Masters Program Applicants and Enrollees

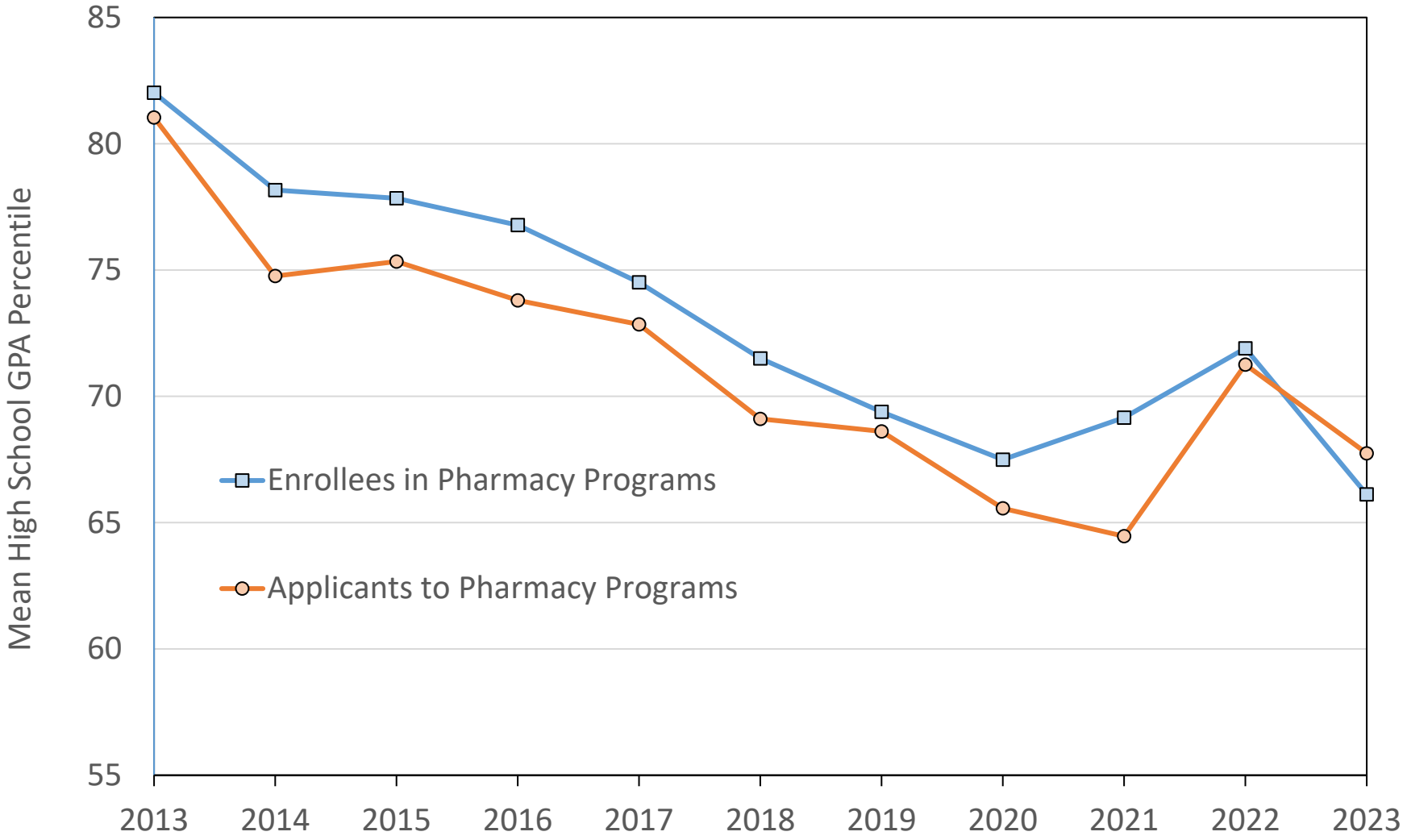


Table 1: Data on Pharmacies and Pharmacists in Portugal, 2005-2022

	2005	2009	2014	2018	2022[d]
Number and total sales of retail pharmacies					
Number of pharmacies, INE	2,670	2,693	2,772	2,805	2,803
Number of pharmacies, SCIE[a]	3,437	3,655	3,561	3,482	3,742
Total sales of pharmacies in SCIE (log real €)	22.028	22.075	21.757	21.831	21.922
Number of pharmacies in QP	2,580	2,756	2,587	2,527	2,498
Number of pharmacies in QP Analysis Sample	1,439	1,928	1,997	2,039	2,125
Total sales of pharmacies in QP-AS (log real €)	21.529	21.814	21.572	21.666	21.781
Share of SCIE sales in QP-AS	0.607	0.770	0.831	0.848	0.868
Characteristics of pharmacists in QP analysis sample (QP-AS)[b]					
Number of pharmacists in QP-AS	2,403	3,767	4,533	6,015	6,920
Female (%)	80.4	80.9	81.0	81.3	81.8
Working full time (%)	89.7	89.6	93.9	92.5	89.2
Mean education (years)	16.6	16.9	16.9	16.7	16.8
Mean age (years)	32.7	33.1	34.0	34.9	36.8
Mean tenure at current firm (years)	3.9	4.1	5.5	5.5	6.5
Covered by CBA (%)	87.9	94.1	91.6	89.1	--
Real monthly wages and wage components of pharmacists in QP-AS (2012=100)[c]					
Geometric mean real montly total wage (Euros)	2,088	2,187	1,669	1,571	--
Mean log real monthly base wage	7.46	7.51	7.25	7.17	--
Mean log real monthly total wage	7.64	7.69	7.42	7.36	--
Mean base wage cushion (base wage - floor)	0.08	0.10	0.04	0.10	--
Mean total wage cushion (total wage - floor)	0.26	0.28	0.21	0.29	--

Source: Authors' computations based on INE, SCIE, and QP. Definition of retail pharmacies varies slightly between INE (National Statistical Institute of Portugal) and SCIE (System of Integrated Accounts). QP Analysis Sample (QP-AS) includes pharmacies (based on SCIE industry classification) that employ at least one wage-earning pharmacist.

Notes:

[a]Count includes pharmacies (as defined in SCIE data set) with positive sales.

[b]Main QP analysis sample (QP-AS) includes only pharmacists reported as wage earners in QP, and covered by a collective bargaining agreement (CBA) for pharmacists or pharmacy technicians, or no CBA. After 2018 QP lacks information on collective bargaining status and definition of QP-AS is not strictly comparable.

[c]Wage outcomes are based on pharmacists who are working full time and covered by a CBA.

[d]Definition of QP-AS not strictly comparable before and after 2018.

Table 2: Summary of Major Changes to Collective Bargaining Agreement

Year	Summary of Provisions
2005 and earlier	- 4 wage floors for pharmacists (plus Technical Director) - promotion to next floor after 1 year (4 years to reach highest level) - 40 hours per week, with overtime premiums: 25% for 1st hour - fixed fee of 110€ for Saturday nights/holidays; 79€ other nights - 22 paid holidays per year; €4.64 per day meal allowance
2006	- 3-4% increases for wage floors; 7.6% for Technical Director
2008	- 3% increases for wage floors; 8.3% for Technical Director
2010	- 1.3% increases for wage floors including Technical Director - re-labelling of existing wage floors - new hours flexibility: up to 2 hours per day (10 per week) added to "hours bank" to be used for time off with no overtime premium - meal allowance increased to €4.68
2012	- introduction of **lower tier wage schedule** if hired after June 2012 with floors 10% below main tier (Technical Directors excluded) - introduction of 5th (lowest) entry level wage tier - promotion to next floor after **2 years** instead of 1, with provision to further slow down to **3 years per floor** after 2014 - main tier workers could move to lower tier in exchange for 1-3 holidays - meal allowance increased to €5.12
2014	- extension of 2012 agreement
2016	- introduction of **performance bonuses for lower-tier workers** based on annual sales to NHS (paid in 1st quarter of next year) - introduction of lower tier for Technical Director if annual sales to NHS below target based on national average of stores - promotion to next floor after **4 years** (instead of 3 as of 2014)
2018	- 1.5% increases for main tier and lower tier floors - 1.1% increase for Technical Director floors
2024	- 4.5% increases in general - 13% increase for entry level tier - promotion to next floor after **5 years**

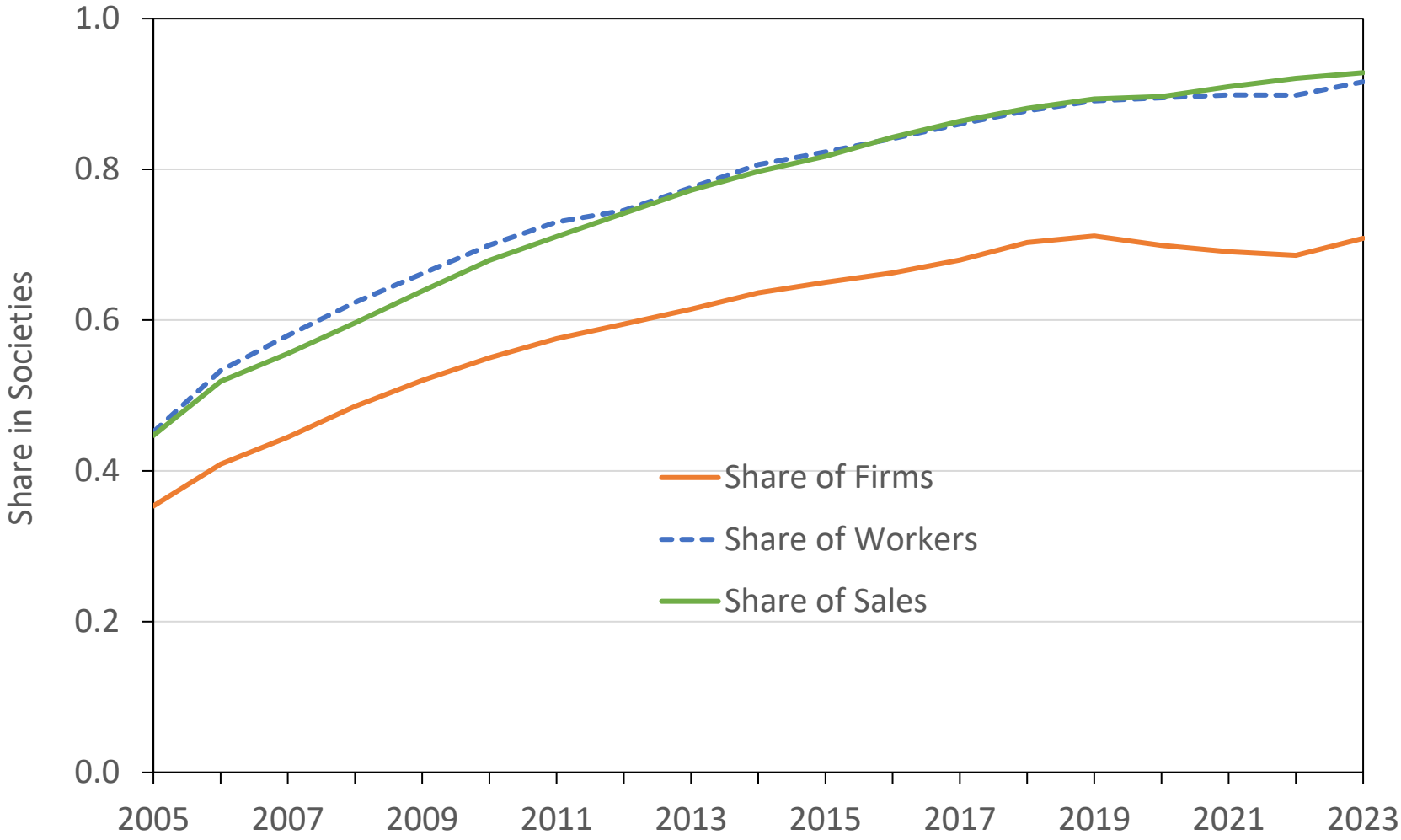
Source: authors' analysis of Collective Bargaining Agreements.

Table 3: Conventional Rent-Sharing Models Estimated for Pharmacists

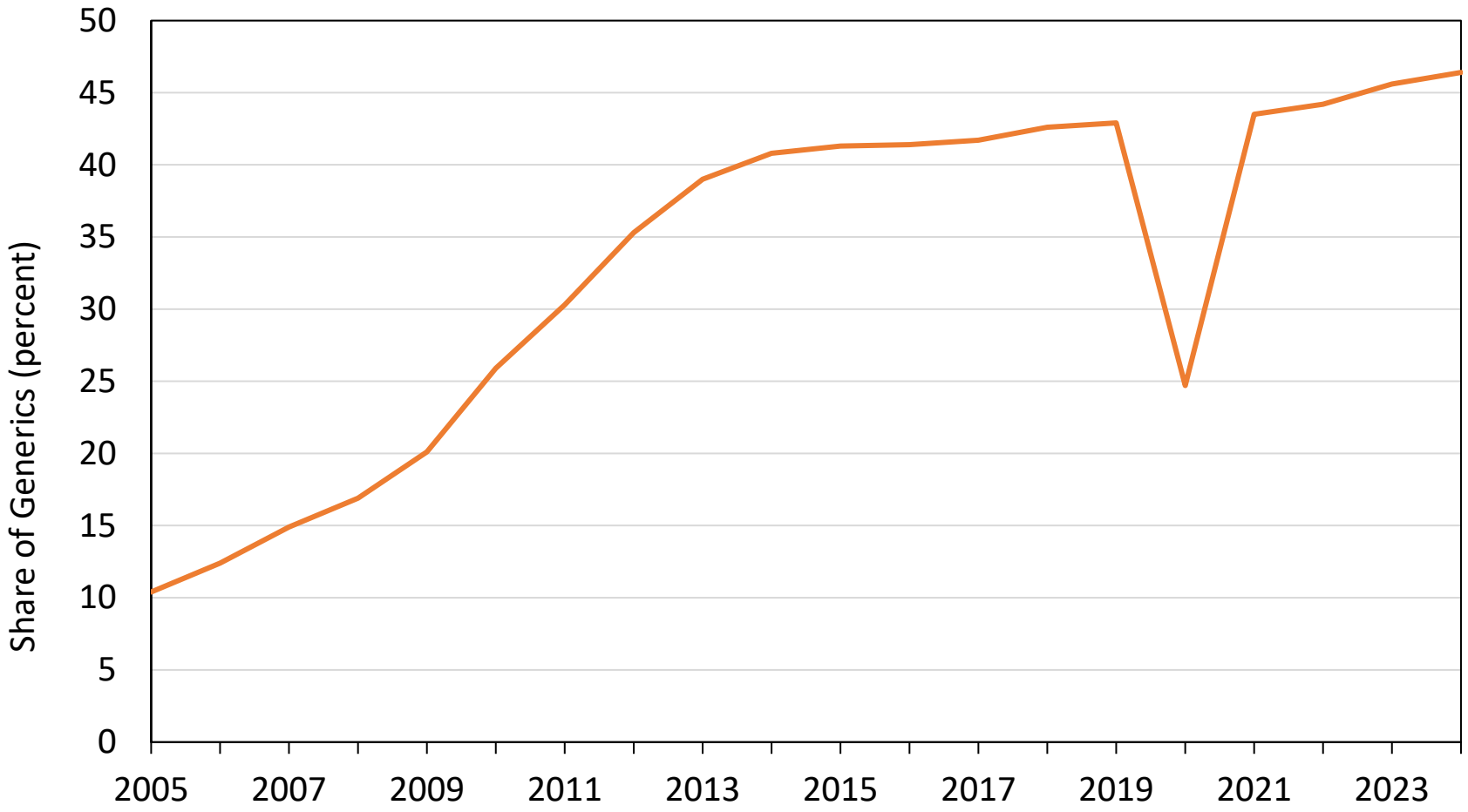
	Log wage floor		Log base wage		Log total wage	
	(1)	(2)	(3)	(4)	(5)	(6)
Log real value added per pharmacist in current year	--	0.013 (0.005)	--	0.040 (0.005)	--	0.053 (0.005)
Firm mean of log real value added per pharmacist	--	-0.018 (0.007)	--	0.060 (0.006)	--	0.065 (0.007)
Dummy for hired after 2012	-0.127 (0.005)	-0.127 (0.005)	-0.194 (0.004)	-0.189 (0.004)	-0.179 (0.005)	-0.174 (0.005)
Controls for worker characteristics and share of pharmacists in total empl.	yes	yes	yes	yes	yes	yes
Year effects	yes	yes	yes	yes	yes	yes
R-squared	0.237	0.237	0.439	0.448	0.354	0.365

Notes: estimated standard errors in parentheses. All models fit to worker-year observations for pharmacists in QP Analysis Sample: sample size is 49,310. Worker characteristics included in all models are: indicator for female gender, years of education, age and its-square, and tenure at current employer and its square. All models also include the log of the share of pharmacists in total employment at the firm in the current year, and the mean value of this variable across all years for the firm.

Appendix Figure 1: Share of Pharmacies Organized as Incorportated Businesses ("Sociedades")

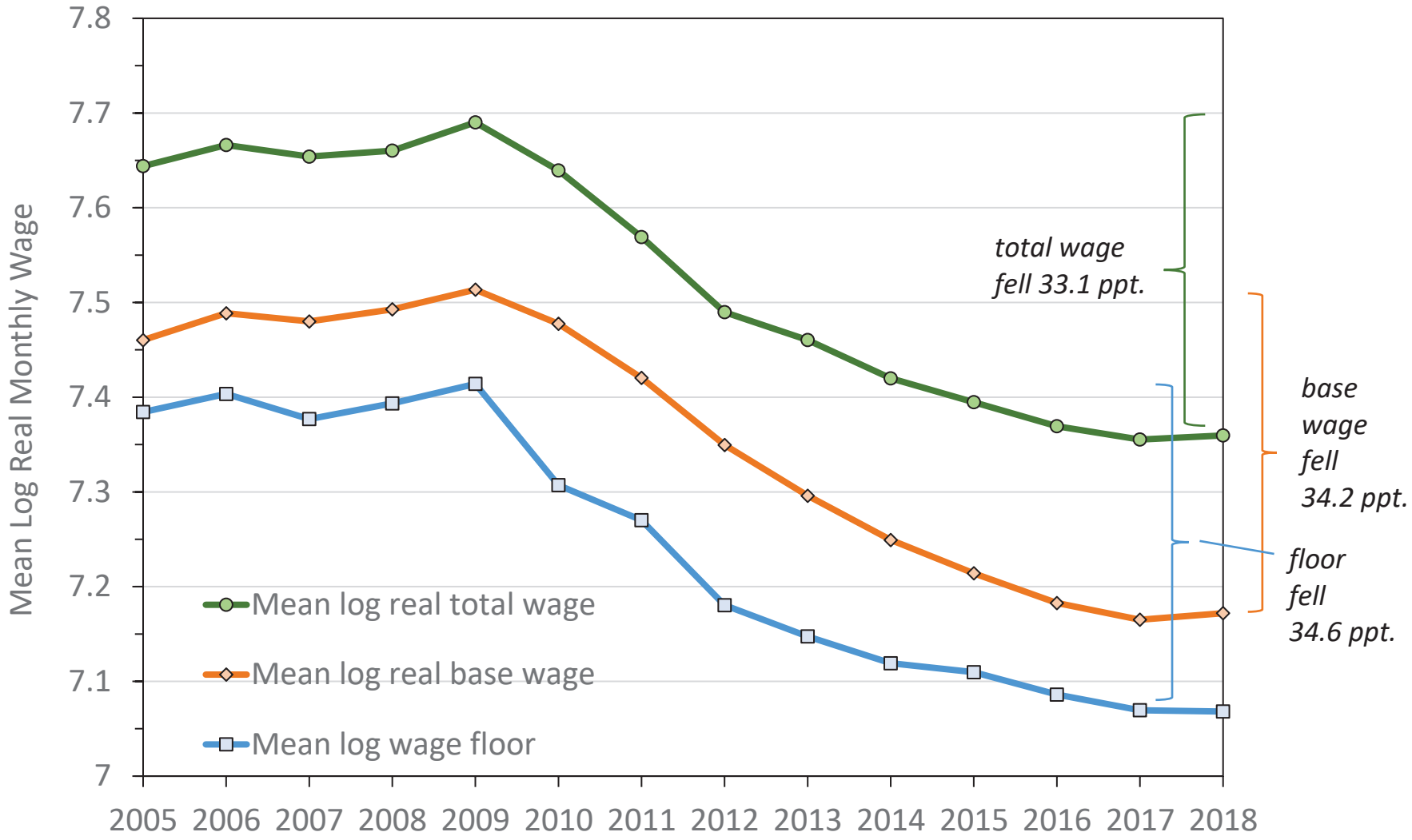


Appendix Figure 2: Share of Generics in Total Prescriptions

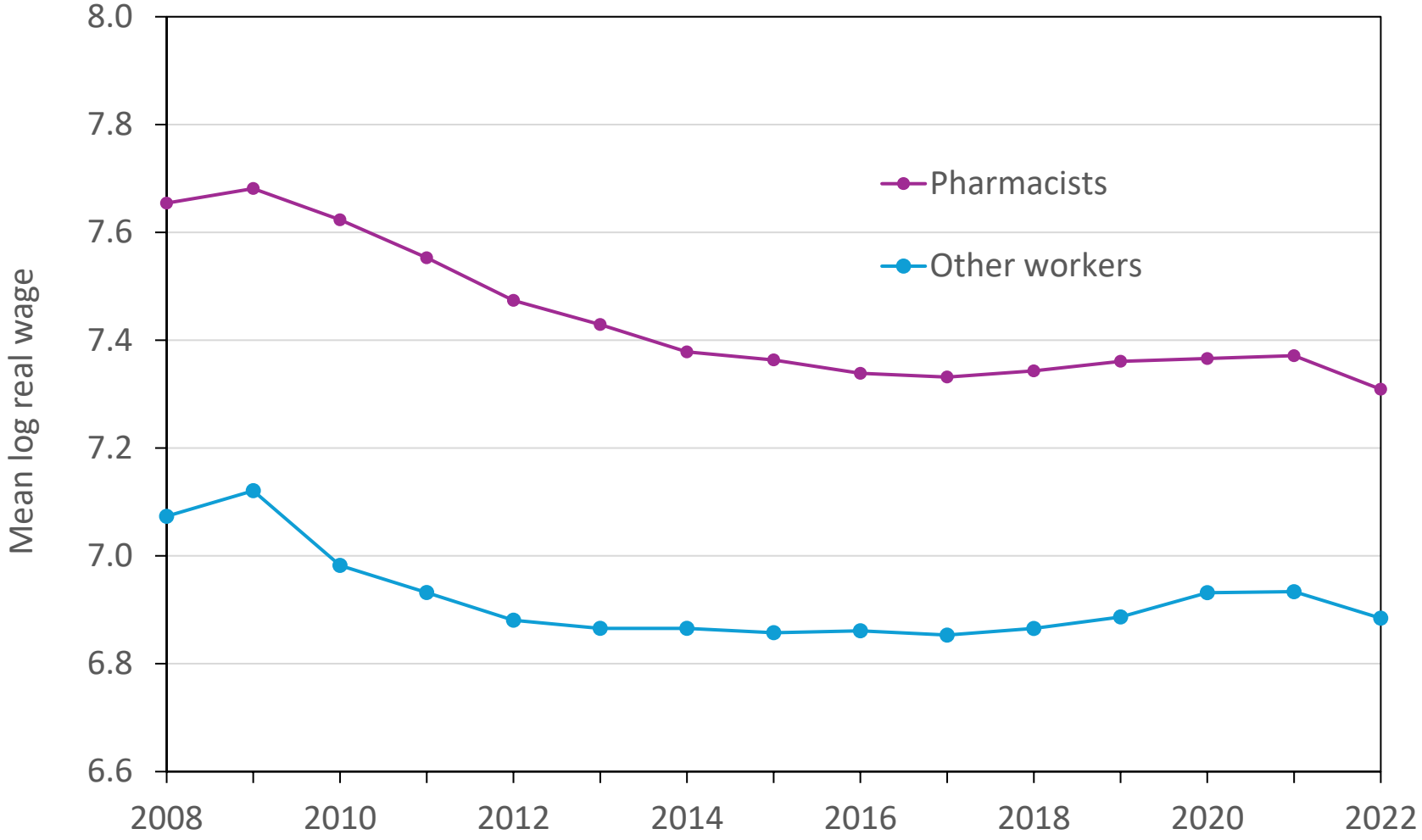


Source: INE, Estatísticas das farmácias. Share represents share of prescription packages sold.

Appendix Figure 3: Evolution of Wages of Pharmacists, 2005-18



Appendix Figure 4: Mean Log Real Base Wage Rates of Pharmacists and Other Workers



Note: Other workers include pharmacy technicians, clerks, and all other paid employees except pharmacists.

Appendix Table 1: Number of pharmacies in mainland Portugal, 2005-2023

		SCIE		Quadros de Pessoal (QP)			
	INE	Total	With positive sales	Total	With 1+ pharmacists	With 1+ wage-earning pharmacist(s)	With wage-earning pharmacist(s) covered by CBA
2005	2,670	3,493	3,437	2,580	1,798	1,455	1,439
2006	2,666	3,654	3,593	2,625	1,843	1,523	1,513
2007	2,666	3,619	3,545	2,689	1,929	1,598	1,590
2008	2,665	3,764	3,657	2,739	2,060	1,795	1,785
2009	2,693	3,762	3,655	2,756	2,165	1,941	1,928
2010	2,768	3,727	3,610	2,635	2,182	1,971	1,929
2011	2,789	3,686	3,564	2,655	2,221	2,065	2,023
2012	2,796	3,654	3,548	2,609	2,178	2,037	2,000
2013	2,777	3,695	3,587	2,582	2,172	2,028	1,975
2014	2,772	3,673	3,561	2,587	2,211	2,058	1,997
2015	2,773	3,704	3,569	2,555	2,186	2,047	1,994
2016	2,774	3,703	3,564	2,544	2,200	2,062	1,991
2017	2,805	3,696	3,554	2,545	2,206	2,096	2,024
2018	2,805	3,629	3,482	2,527	2,209	2,101	2,039
2019	2,806	3,636	3,496	2,480	2,185	2,076	(*)
2020	2,804	3,730	3,575	2,504	2,222	2,114	(*)
2021	2,803	3,819	3,671	2,434	2,163	2,062	(*)
2022	2,803	3,887	3,742	2,498	2,231	2,125	(*)
2023	2,802	3,937	3,776	--	--	--	--

Sources: INE, SCIE, and QP.

Note: (*) The analysis sample of QP includes only wage-earners covered by the collective bargaining contracts of pharmacists or pharmacy technicians or not-covered. Data on collective bargaining contract coverage is not available after 2018.

Appendix Table 2: Number of Pharmacists in Mainland Portugal, 2005-2018

	INE			QP pharmacists in pharmacies	
	All	In Retail Pharmacies	Percent in Pharmacies	All	Analysis Sample[a]
2005	9,189	5,540	0.60	3,446	2,403
2006	9,751	5,746	0.59	3,688	2,634
2007	9,795	6,070	0.62	4,005	2,873
2008	10,382	6,691	0.64	4,477	3,318
2009	11,001	7,222	0.66	5,004	3,767
2010	10,544	7,424	0.70	5,182	3,959
2011	11,504	7,671	0.67	5,422	4,228
2012	10,636	7,497	0.70	5,280	4,167
2013	11,005	7,804	0.71	5,399	4,259
2014	11,373	8,093	0.71	5,775	4,533
2015	11,718	8,418	0.72	6,085	4,875
2016	12,064	8,502	0.70	6,571	5,328
2017	12,575	9,026	0.72	6,880	5,680
2018	13,043	9,288	0.71	7,209	6,015
2019	13,410	9,285	0.69	7,382	6,350
2020	13,740	9,502	0.69	7,638	6,577
2021	15,495	9,803	0.63	7,674	6,570
2022	15,658	10,257	0.66	8,028	6,920
2023	15,923	10,110	0.63	--	--
2024	16,117	10,432	0.65	--	--

Source: Based on data from INE and authors' analysis of QP. 2013 value for all pharmacists in INE data is interpolated.

Note:

[a] QP Analysis Sample (QP-AS) includes only wage-earners covered by the collective bargaining contracts of pharmacists or pharmacy technicians or not-covered by any agreement. After 2018 collective bargaining information is not available in QP and numbers of pharmacists in QP-AS are not comparable.

Appendix Table 3: Mobility rates of Pharmacists between Job Titles of Pharmacist and Pharmacy Technician, and Associated Changes in Wage Floors and Base Wages

	Mobility rates (%)		Change in mean log real wage floor for movers		Change in mean log real base wage for movers	
	From Pharmacist to Pharm. Tech	From Pharm. Tech to Pharmacist	From Pharmacist to Pharm. Tech	From Pharm. Tech to Pharmacist	From Pharmacist to Pharm. Tech	From Pharm. Tech to Pharmacist
	(1)	(2)	(3)	(4)	(5)	(6)
2006	0.93	38.29	-0.829	0.875	-0.011	0.038
2007	1.23	25.68	-0.914	0.786	0.018	0.022
2008	1.14	27.27	-0.793	0.853	0.026	0.046
2009	0.55	22.22	-0.872	0.937	0.195	0.123
2010	11.04	29.73	-0.820	0.962	0.004	-0.007
2011	1.58	16.12	-0.836	0.729	0.012	-0.030
2012	12.35	21.58	-0.789	0.755	-0.053	-0.009
2013	1.78	44.44	-0.717	0.779	-0.027	0.002
2014	1.85	14.29	-0.691	0.700	-0.049	-0.050
2015	1.42	12.61	-0.751	0.655	-0.008	0.044
2016	13.71	18.52	-0.692	0.622	0.021	0.028
2017	2.3	16.2	-0.662	0.601	-0.005	0.046
2018	2.51	12.41	-0.574	0.608	0.056	0.059

Note: Based on QP Analysis Sample of paid employees in retail pharmacy sector with occupation of "Pharmacist" in current and previous year. These workers can have a job title of "Pharmacist", which would imply they are covered by the CBA for Pharmacists, or a job title of "Pharmacy Technician", which would imply they are covered by the CBA for Pharmacy Technicians. Across all years of the Analysis Sample there are 36,844 Pharmacists whose job title in the previous year was "Pharmacist": their outflow rates are shown in column 1, their mean change in log real wage floors is shown in column 3, and their mean change in log real base wages is shown in column 5. Across all years of the Analysis Sample there are 6,439 Pharmacists whose job title in the previous year was "Pharmacy Technician": their outflow rates are shown in column 2, their mean change in log real wage floors is shown in column 4, and their mean change in log real base wages is shown in column 6.