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Alfredo Marvão Pereira, Rui Manuel Pereira and Pedro G. Rodrigues

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Health Care Investments and Economic Performance in Portugal: An Industry Level Analysis [1]

Alfredo Marvão Pereira [2], Rui Manuel Pereira [3] and Pedro G. Rodrigues [4]

Abstract

We analyze how public and private health care investments affect economic performance in Portugal. With a newly-developed data set for twenty-two industries, we use a vector autoregressive model to estimate the elasticities and marginal products on investment, employment and output. First, every €1 million invested in health care yields significant positive spillover effects, boosting investment and GDP by €24.74 and €20.45 million, respectively, and creating 188 net jobs. Adversely, net exports deteriorate, as most of the new capital goods are imported. Second, while only 28.2% of the total accumulated increase in GDP occurs within a year, investment is front-loaded with a corresponding 73.8%. Over this period, 68 workers are displaced for every €1 million invested. Third, at a disaggregated level, real estate, construction, and transportation and storage are the three industries where output shares increase the most. Employment shares increase the most in professional services, construction, and basic metals. These results have important policy implications. Health investments enhance long-term performance, but are unhelpful counter-cyclically. Also, they will change the industry mix: construction and professional services are the non-traded industries that will benefit the most, while the traded industries of non-metallic minerals, basic metals, and machinery and equipment benefit much less.

JEL Classification: C32, E22, H54, O52, L90, L98.

Keywords: Health care investment; Economic performance; Industry mix; Vector autoregressive; Portugal.

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[2] Department of Economics, The College of William and Mary, PO Box 8795, Williamsburg VA 23187, United States of America

[3] Department of Economics, The College of William and Mary, PO Box 8795, Williamsburg VA 23187, United States of America

[4] Centro de Administração e Políticas Públicas (CAPP), and Instituto Superior de Ciências Sociais e Políticas (ISCSP), Universidade de Lisboa, Rua Almerindo Lessa, 1300-663 Lisboa, Portugal

1. Introduction

Since the 1980s, the health care industry in Portugal has more than doubled in size, with a relative contribution to GDP growing from 2% in the 1980s to 4.5% in the 2000s [1]. Over the same period, health care investments also more than doubled their share in GDP, from 0.34% in the 1980s to 0.75% in the 2000s [2]. One would expect such sustained investment efforts to not only boost overall activity at the aggregate level, but also to reallocate resources, thereby altering the country's industry mix. Furthermore, because capital takes time to build, investments are impulses where short- and long-run economic impacts can differ substantially.

Health care investments are expected to have different types of effects. First, there are short-term demand-side effects that are induced by the construction of the infrastructure, and how this reverberates throughout the economy, namely in the industries it relies upon [3, 4:74, 5]. But, in the short run, there are also disruptions in economic activity related to construction, namely in the health care industry itself. Over time, the health facilities and services made available by such investments require maintenance and operations expenses, thus extending the demand-side channels into the longer term [3, 4:75, 6:146]. Second, there are long-term supply-side effects that reflect the impact on economic performance, productivity, and improved health outcomes over time of the availability of new health care equipment and infrastructures [7, 8]. Furthermore, one could single out a location effect, as the existence of health care facilities has a regional impact, attracting both population and business. Important effects will follow, for example, for the trade and real estate industries [3, 5, 6:150, 7-9].

In this context, this paper addresses four major public policy questions related to the economic effects of health care investments. First, from a more aggregate perspective, what impact would we expect on GDP, on private investment and on employment, and would the trade balance likely improve or worsen? Second, still from a macroeconomic perspective, would health care investment yield most of its effects in the short term, meaning that it could be part of the authorities' counter-cyclical toolbox used to regulate aggregate demand and temporarily reduce unemployment? Third, from an industry perspective, how do health care investments affect economic activity? Which sectors benefited the most, and what does that tell us in terms of the channels through which the economy is affected? And, finally, still from an industry perspective, how would these developments affect the industry composition in terms of the traded/non-traded divide? Despite their significance to a wide range of policymakers, these issues are rarely investigated internationally, and have never been studied in the case of Portugal.

These public policy questions are both timely and pertinent for Portugal. Every year, the State Budget [10], in addition to specifying the outlays and their sources of financing, ought to include their economic impacts, an exercise where consistency is key. Similarly, the Stability and Growth Program [11], a five-year rolling multi-annual fiscal framework, ought to include the dynamic impacts of capital spending over time. Domestic authorities other than at the Finance Ministry need to know not only how health care investments affect macroeconomic aggregates, but also how these will impact the industry mix. Furthermore, given the economy's position in the business cycle, authorities need to know whether health care investments can indeed be a countercyclical instrument, or not. In addition, these questions are critical for labor market policies, for employment and vocational training planning agencies who need to prepare for job destruction in certain industries, and for institutions of higher education who strategically plan for industry-specific job opportunities. Finally, industrial policies need to incorporate the effects of health care investments, as these are sure to change the industry mix.

These public policy questions are also of great relevance internationally. In both formulating and evaluating cross-national public policies, international organizations, too, inquire about these issues [12, 13]. For instance, pro-cyclical fiscal policy is a recurrent concern of the IMF, as well of the OECD [14, 15]. Moreover, in the context of a host of EU structural funds – that includes the Investment Plan for Europe, Horizon 2020, and the European Fund for Strategic Investments (EFSI) – that co-finance national health care investment projects, the European Commission is particularly interested not only in the aggregate macroeconomic effects, but increasingly also in the industry-level effects of these, mainly with the aim of improving territorial cohesion and ensuring consistency with other sectoral policies [16]. Health care investments contribute to smart and inclusive growth [17], they ought to be integrated into a sustainable development strategy [18], and be geared to creating jobs and shifting to a low-carbon economy [19, 20]. Furthermore, there can be significant spillovers to the rest of the economy, as these investments promote entrepreneurship in businesses related to the health care industry and aid the development of health tourism centers [21].

To address these issues, we use a multivariate dynamic time series approach, first developed in Pereira [22, 23], and subsequently applied to the US, in Pereira and Andraz [24, 25], to Spain, in Pereira and Roca-Sagales [26-28], and to Portugal, in Pereira and Andraz [29-31]. We work with a novel data set on infrastructure investments developed by Pereira and Pereira [2], and consider twenty-two industries that span all economic activity. For each industry, we use a vector-autoregressive (VAR) model to estimate the effects of health care investments on output, employment, and private investment in that industry. By analyzing the resulting impulse response functions, we obtain a decomposition of the marginal products between the short-term demand effects upon impact and the long-term supply side effects.

This approach is eminently empirical but it is not atheoretical. In fact, each VAR system can be conceptualized as a dynamic reduced form of an industry-specific production function coupled with input demand schedules for labor and for private capital, and a policy function for health investment in the country. Health care investments are thus viewed as non-rival externalities to the production in each industry. For each industry, the VAR system captures the direct role of health care investments as inputs in production, as well as the indirect role they play through their effect on the demand for other inputs. This approach is particularly well-suited to capture the dynamic nature of the relationship between health investments and economic performance in each industry. It explicitly addresses the contemporaneous relationships in the innovations in each variable. In addition, it incorporates the dynamic intertemporal feedbacks among the variables. And, it accommodates the possibility of long-run cointegrating relationships. Built into this approach is the simultaneous endogeneity of all variables and the identification of causal relationships.

The rest of this article proceeds as follows. Section 2 presents a literature review, and Section 3 presents the data, while Section 4 discusses preliminary statistical data analysis. Section 5 focuses on the empirical results, discussing the industry-specific long-term effects of health care investments, their outcomes on impact, and ultimately their changes to the industry mix. Finally, Section 6 provides a summary of the results and their policy implications.

2. Literature Review

This research is at the crossroads of two branches of the economics literature. On one hand, we have the literature on the economic effects of infrastructure investment. Aschauer [32] is the seminal reference, and Gramlich [33] and Munell [34] provide surveys of the early literature, using a univariate and static production function approach. More recently, Romp and de Haan [35], De la Fuente [36], Pereira and Andraz [37], and Bom and Ligthart [38] provide reviews of the empirical literature considering a much greater array of methodologies. This paper, given its scope and methodological approach, fits directly into this literature.

In addition, this paper connects thematically to the literature on the economic performance effects of health care expenditure. Good health is not only a consumption good, but is increasingly considered an investment good [39-41]. In this context, spending money on health is an investment in human capital that complements education and spurs growth. Furthermore, by lengthening one's lifespan, it may prompt the need to further save for retirement, thus increasing the stock of capital in the economy. Empirically, studies such as Erdil and Yetkiner [42] and Amiri and Ventelow [43] find evidence of bi-directional causality between health care spending and income, while, for Wang [44], faster health care expenditure accelerates economic growth. Rivera and Currais [45] find that health care spending improves the fit of regressions that explain cross-country differences in per capita income. Nonetheless, Weil [46] reminds us that, although several studies find evidence of health care spending improving economic performance, the effects found are typically small, and that variables such as the quality of institutions and human capital drive both higher income and better health outcomes, meaning that the direction of causality between health care spending and income is hard to tease out.

The literature on the economic effects of health care investments is even scarcer at the industry level. Most of the little research available has a regional focus at an aggregate level of analysis, and tends to consider 'social infrastructure', that bundles together education, social welfare and health infrastructures. But, as the literature on fiscal multipliers has shown [47-49], in determining the output effects of public spending, it is important to disaggregate, not only by taking into account different sectors, but also by separating current from capital spending. Rivera and Currais [50] find that, for regions in Spain, public investment in health care (in the form of buildings, land and equipment) has no effect on productivity, but this could be because social infrastructure takes longer to manifest itself than economic infrastructure, such as roads and highways. Similarly, Mas, Maudos, Pérez and Uriel [51], for Spain, and Rodríguez-Pose, Psycharis and Tselios [52], for Greece, also find no effect of investments in social infrastructure, but in both cases health care is not singled out. Focusing on less-developed countries, Kara, Tas and Ada [53] and Misra [54], studying Turkey and India, respectively, find that investments in social infrastructure have a larger effect on income and productivity than investments in economic infrastructure. Ball and Nanda [55] focus on regions in England, and conclude that social infrastructure investments promote residential housing but not commercial property. Cutanda and Paricio [56] study Spain and explicitly consider investments in health care infrastructure. Although there is no industry-level analysis and their framework is static and cross-regional, this is thematically one of the research pieces closest to ours. They conclude that this type of infrastructure helps to explain income disparities across regions. Another relevant piece of research is Pereira and Pereira [57], a study for Ontario, Canada, where, in a similar methodological framework as ours, health investments are found to have rather important aggregate effects. Again, no industry-level analysis is provided.

3. Data Sources and Description

3.1. The Health Care Investment Data Set

The data for health care investment cover the period spanning 1978 to 2011, and are a part of a new data set on public and private infrastructure investment in Portugal, developed by Pereira and Pereira [2]. This new data set includes twelve individual types of infrastructures, grouped into four main categories: road transportation infrastructure (national roads, municipal roads, and highways), other transportation infrastructure (railroads, airports, and ports), social infrastructures (education and health), and utilities infrastructure (electricity and gas, water and sewage, petroleum refining, and telecommunications).

Health care investments include expenditures on both new and used buildings, on equipment, and on means of transportation. With regards to the decomposition of health care investments, for which no information is included in this new data set, data from several issues of the General State Account suggest [58] that, in 2015, 64.7% of the total public capital spending was on equipment, 32.4% on infrastructure, and the remaining 2.8% on means of transportation. Since 2005, infrastructure and vehicles have both slightly increased their share. On the other hand, at present, there is no data to compute this split for health care investments carried out by the private sector.

Table 1 presents summary statistics on health care investments, both as a percent of GDP, and as a share of infrastructure investment. Specifically, in our sample period, investment in health facilities averaged 0.55% of GDP, or 10.74% of total investment. Investment in health facilities increased steadily, both as a percent of GDP, and as a percent of total infrastructure investment. In three decades since the 1980s, health care investments more than doubled their share in GDP, averaging 0.75% of GDP in the 2000s.

Overall, infrastructure investments grew substantially over the sample period, averaging 2.88% of GDP in the 1980s, 4.40% in the 1990s, and 5.04 % in the 2000s. This increase was particularly pronounced after 1986, the year Portugal joined the European Union (EU), and in the 1990s in the context of the EU Structural and Cohesion Funds, with the Community Support Framework (CSF) I (1989-1993), and the CSF II (1994-1999). More recently, capital spending decelerated substantially during the CSF III (2000-2006) and the QREN (2007-2013). These landmark dates for joining the EU, as well as the start of the different community support frameworks, are all considered as potential candidates for structural breaks in every single step of the empirical analysis that follows.

3.2. The Industry Data Set

We consider twenty-two industries that span all of economic activity in Portugal, and are grouped into four sectors: the primary sector, the secondary sector, private services, and public services. The tertiary sector encompasses the latter two sectors. Table 2 details the composition of each sector and its constituent industries. The primary sector is made up of agriculture and mining. The secondary sector incorporates manufacturing, and includes food, textiles, paper, chemical and pharmaceutical, non-metallic minerals, metallic, and machinery industries. In the tertiary sector, electricity, water, construction, trade, transportation, hospitality, telecommunications, finance, real estate, and professional services together make up private services, while public services include public administration, health and education.

Output, employment, and investment are the economic data for each of the twenty-two industries considered. These are obtained from different annual issues of the National Accounts, published by Statistics Portugal (available at www.ine.pt). Output and private investment are measured in millions of constant 2005 Euros, while employment is measured in thousands of employees.

Summary statistics on the change in the industry mix during the sample period are provided in Table 3. The output share of the primary and the manufacturing sectors has declined since the 1980s, albeit more sharply in the case of agriculture and mining. The primary sector accounted for 14.1% of output in the 1980s, and declined by three-quarters to just 3.4% in the 2000s. Over the same period, the manufacturing sector declined by a quarter from 20.5% to 15.1%. In part, private services picked up the slack, as its share rose from 52.7% in the 1980s, to 60.3% in the 2000s. Public services increased by 66% over the sample period, with an output share that rose from 12.8% in the 1980s, to 21.2% in the last decade.

Of all twenty-two industries considered, health care [S22] was where the contribution to GDP grew the most over the past thirty years, with an increase of 125% from just 2% of GDP in the 1980s, to 4.5% by the 2000s. By the last decade, health care's share in GDP was just as big as other industries, such as transportation and storage [S14] or hospitality [S15]. Given the importance of accommodation and food services to Portugal, a country which relies heavily on tourism, this is evidence of just how much the health industry has grown. Nevertheless, and despite this growth, in the 2000s, health care represented just 21.2% of all economic activity in the public services sector, compared to 46.7% in public administration and 32.1% in education.

4. Preliminary Data Analysis [5]

4.1. Unit Roots, Cointegration, and VAR Specification

We start with unit root and cointegration analyses. Having determined that stationarity seems to be a good approximation for all series, and in the absence of any evidence for cointegration, we follow the standard procedure in the literature and determine the specifications of the VAR models using growth rates of the original variables.

We estimate one VAR model for each of the twenty-two industries. This includes industry-specific output, employment, and private investment, as well as health care investments. We use the BIC to determine structural breaks and deterministic components to be included. Our test results suggest that a VAR specification of first order with a constant and a trend, as well as structural breaks in 1989, 1994, and 2000, the years of the inception of the first three community support frameworks, is the preferred choice in the overwhelming majority of the cases.

4.2. Identifying Exogenous Innovations in Health Care Investments

The key issue in determining the impact of health care investment is the identification of exogenous shocks in these investments that are not contaminated by other contemporaneous innovations. In dealing with this issue, we draw on the approach followed in dealing with the effects of monetary policy [59-61], and adopted by Pereira [22] in the context of the analysis of the effects of infrastructure investment.

The identification of exogenous shocks to health investments would, in general, result from knowing what fraction of the government appropriations is due to purely non-economic reasons. The econometric counterpart is to consider a policy function which relates the rate of growth of health investments to the relevant information set. The residuals from these policy functions reflect the unexpected component of the evolution of health investments and are, by definition, uncorrelated with innovations in other variables.

[5] For the sake of brevity, we just sketch here the different steps in the preliminary data analysis. Full documentation is available from the authors upon request.

We assume that the relevant information set includes past but not current values of the economic variables. In the context of the standard Choleski decomposition, this is equivalent to assuming that innovations in health investments lead innovations in economic variables, i.e., that while innovations in health investments affect the economic variables contemporaneously, the reverse is not true. This also means that the estimated effects of health investments are invariant to the ordering of the three economic variables.

We have two conceptual reasons for this assumption. First, it seems reasonable to assume that the economy reacts within a year to innovations in health investments. Second, it also seems reasonable to assume that the public sector, which is responsible for the bulk of these investments, is unable to adjust health investments decisions to innovations in the economic variables within the same year. This is due to the time lags involved in information gathering and public decision making.

Furthermore, this assumption is reasonable also from a statistical perspective. Invariably, the policy functions point to the exogeneity of the innovations in health investment, i.e., the evolution of health investments does not seem to be affected by the lagged evolution of the remaining variables. This is to be expected because health investments were very much linked to EU support programs, and therefore not responsive to the ongoing economic conditions. Moreover, we would not expect any single economic industry to have an impact on decision making for health investments at the national level.

4.3. Measuring the Effects of Innovations in Health Care Investments

To measure the effects of a one-percentage point, one-time shock in the rates of growth of the health investments on output, employment and private investment, we estimate the accumulated impulse-response functions for each of the twenty-two VAR models. These functions typically converge within a relatively short time period. Error bands surrounding the point estimates for the accumulated impulse responses are computed via bootstrapping methods. We consider 90% intervals, although bands that correspond to a 68% posterior probability are the standard in the literature [62]. When the 90% error bands include zero, we consider that the effects are not significantly different from zero.[6]

To measure the effects of shocks in health investments, we calculate the total long-term accumulated elasticities and marginal products of the different industry-specific outputs with respect to health investments. These concepts depart from the conventional understandings, because they are not based on *ceteris paribus* assumptions, but, instead, they include all the dynamic feedback effects among the different variables.

The total long-term accumulated elasticities are to be interpreted as the total accumulated long-term change, measured in percentage points, stemming from a one-percentage point accumulated long-term change in health investment. In turn, the total long-term accumulated marginal products measure the change, per additional euro in health care investment. The marginal products are obtained by multiplying the average ratio to health care investment by the corresponding elasticity. We use the average ratio over the last ten years of the sample. Using a recent time period allows the marginal products to reflect the relative scarcity of health care investments at the margin of the sample period, while the choice of ten years prevents these ratios from being overly affected by business cycle factors.

[6] Again, for the sake of brevity, the impulse response functions have been omitted. Full documentation is available from the authors upon request.

Health care investments can be expected to have basically two types of effects. First, there are short-term demand-side effects that are induced by the very implementation of the investment efforts, mainly the construction of the infrastructure, and how this activity reverberates throughout the economy. Second, there are longer-term supply-side effects that reflect the impact on economic performance of the availability of new capital, both in the form of new medical equipment and of infrastructure. In Table 4, we report the long-term accumulated elasticities and marginal products. In turn, in Table 5, we report the decomposition of those total accumulated results in a way that shows how much is due to effects on impact.

5. On the Economic Effects of Health Care Investments

In this section, we start by presenting the aggregate effects of health care infrastructures as a way of framing our industry-specific results. Then, we consider the results at the industry level, both the accumulated long-term effects and the outcomes on impact, and proceed to identify what these results imply in terms of the channels through which such investments affect economic performance. Finally, we consider the effects of health care investments on the industry mix in the country with an eye on the traded/non-traded divide.

5.1. On the Aggregate Effects of Health Care Investments

For the economy as a whole, we estimate that, in the long term, for every €1 million invested in the health care industry, aggregate private investment increases by €24.74 million, and output rises by €20.45 million. We further estimate that around 188 new permanent jobs are created. These results imply that health investments are very effective in promoting long-term economic performance. However, with private investment outpacing output, in a context where private consumption and public spending are also set to rise, the fundamental identity in macroeconomics implies that net exports will fall. This is not surprising, as a significant part of the induced capital spending is likely to come from abroad.

It is surprisingly difficult to make meaningful international comparisons. This is because different studies use different econometric methodologies, sample periods and data definitions, thus making their estimates naturally hard to interpret. For this reason, we compare our results with evidence on the output multiplier of investments in health care infrastructure in strictly comparable cases. Focusing on Ontario, Canada, and using data that spans 1976 through 2011, Pereira and Pereira [57] estimate an output multiplier of 23.46, and a corresponding 99.85 net jobs created for each one million CDN$ in health care investments [7:37]. Our estimates, 20.45 and 188, respectively, are of the same order of magnitude. Pereira [22] focuses on the US, uses data from 1956 through 1997, and is less directly comparable. He finds an output multiplier of 5.53, but the typological scope differs, as he considers investments in social infrastructure that, in this particular case, in addition to health, includes education and administrative buildings. These comparisons allow us to address the disaggregated issues below with great confidence as the aggregate results presented here are well within the realm of the most directly comparable results.

In turn, we estimate rather different patterns of the relationship between short- and longer-term effects for the different economic variables. With respect to employment, the short- and longer-term impacts differ in sign. Due to construction disruptions, to inter-industry reallocations of labor, and to time lags involved in new hiring, we estimate that a health care investment of one million euros leads to a short-term net loss of around 68 jobs. On account of longer-term supply-side effects, however, over time, an additional 256 jobs are created, tallying an overall net job

creation of 188 permanent jobs for every one million euros invested in the health care industry. Regarding private investment, however, we see the very opposite pattern, as the effects of health care investments are front loaded, with 73.8% of the accumulated increase in private investment taking place within one year. Since private investment effects are front-loaded, while short-term employment effects are actually negative, this implies that the short-term output effects will fall somewhere in between. For the economy as a whole, 28.2% of the accumulated increase in output occurs in the short run.

5.2. On the Long-Term Accumulated Industry-Level Effects

Drilling down to the economic effects of health care investments at the industry level, we find that real estate [S18], construction [S12], and transportation and storage [S14] are the three industries with the largest impacts in terms of output, with marginal products of €6.64, €5.93, and €3.31, respectively. Together, these three industries see a boost that represents almost 77% of the induced increase in GDP. Professional services [S19], and machinery and equipment [S9] come next, with marginal products of €1.97, and €1.93, respectively. Positive effects are also observed in paper [S5], and in the non-metallic minerals [S7] industry. On the other hand, output in the water industry [S11] is estimated to drop 68 cents for every euro invested in health care, on account of the overall change in the industry mix.

With respect to the industry-by-industry effect on employment, the biggest employment opportunities are expected in professional services [S19] and in construction [S12], with estimated marginal products of around 102 and 98 jobs, respectively. Together, these two industries create slightly more permanent jobs, 200, than the aggregate net change in employment that is induced by health care investment itself, around 188. This means that we would expect a significant reallocation of the labor input between industries, with workers moving mostly out of agriculture [S1], health care [S22], textiles [S4], and, to a lesser extent, telecommunications [S16], and taking up employment in professional services [S19] and in construction [S12], as well as in other less significant industries, the likes of basic metals [S8], transportation and storage S14], machinery and equipment [S9], non-metallic minerals [S7].

Regarding the industry-by-industry impact of health care investments on private investment, our results suggest that the four industries with the highest marginal products are water [S11], real estate [S18], finance [S17], and professional services [S19], with an estimated €3.43, €3.31, €3.25, and €3.10, respectively. Together, these effects account for 52.2% of the overall boost in investment. The next tier includes industries such as electricity and gas [S10], and public administration [S20]. Then, there are several smaller effects in textiles [S4], chemicals and pharmaceuticals [S6], non-metallic minerals [S7], and basic metals [S8].

It is interesting to focus on the effects in the health care industry [S22] itself. The total marginal product with respect to investment is €1.10, meaning that an initial health care investment induces an extra 10% of capital spending. More importantly, our empirical results suggest that investments in the health care industry – that upgrade both the surrounding infrastructure and the medical equipment – are expected to lead to a net loss of jobs in this same industry. An estimated 19 jobs would be displaced for every million euros of capital spending in health care. Thus, we find evidence that, in this industry at least, at the margin, capital and labor are substitutes. With an unchanged output in this industry, this means that wages ought to rise, in tandem with productivity.

5.3. Long-Term Accumulated Effects versus Effects on Impact

We consider now the relationship between short- and longer-term effects for the different economic variables in the different sectors. With respect to output, there are four industries where long-term effects dominate short-run impacts. By decreasing order of significance, we find this outcome in real estate [S18], construction [S12], transportation and storage [S14], professional services [S19], and in machinery and equipment [S10], where the estimated longer-term marginal products (that ignore the effects on impact) are €5.01, €3.94, €2.16, €1.72 and €1.3, respectively. In general terms, the top three industries with the strongest short-term impacts are construction [S12], real estate [S18], and transportation and storage [S14], with €1.99, €1.63, and €1.15, which capture 82.7% of the short-term output effects.

Regarding employment, where we did find negative aggregate short-term effects, we see that these negative effects come mostly from adverse effects on agriculture [S1], textiles [S4], and health [S22], effects which are amplified in the longer term, but also on construction [S12] where the long-term effects become overwhelmingly positive. We do, however, observe short-term positive effects in non-metallic minerals [S7], basic metals [S8], and machinery and equipment [S9], where such short-term positive effects are amplified over time. Industries worth singling out include construction [S14], where we find capital intensive short-term activities, and health care [S22], where construction disruptions significantly depress employment.

With respect to private investment, generally speaking, the top industries with the largest marginal products on impact are: finance [S17], real estate [S18], and water [S11]. Public administration [S20], professional services [S19], electricity and gas [S10] wholesale and retail trade [S13], and construction [S12] follow close behind. Furthermore, while the positive short-term effects tend to be reinforced over time, the increase is not large. In fact, in the case of finance [S17], the short-term effects exceed, albeit only marginally, the long-term accumulated effect. This evidence confirms the idea that, following a health care investment, capital spending in other industries seems to be frontloaded.

The contrast between the total long-term effects and the effects on impact are very informative in the case of the health industry [S22] itself. We find that the effects on private investment are exclusively on impact, which means that health care investments do not seem to be self-reinforcing over time. We also find that the bulk of the permanent employment losses occur in the short term. Accordingly, although there is no significant output effect, there are significant input-substitution effects which occur essentially on impact.

5.4. What We Can Learn About the Nature of the Effects of Health Care Investments

Considering the dichotomies between short-term and long-term effects, as well as between demand-side and supply-side effects, allows us to identify the channels through which investments in health care affect economic performance.

In terms of output, we saw that short-term demand effects are 28.2% of the total, of which the bulk are in construction [S12], transportation and storage [S14], and real estate [S18]. In turn, long-term construction [S12] effects are 19.3% of the total. Accordingly, what are, strictly speaking, demand-side effects account for 47.5% of the overall output effects. The remaining long-term effects, 52.5%, are dominated by location effects – with real estate [S18] tallying 24.5% of the total effects. Long-term operation effects are also very significant as captured by transportation [S14], with 10.6%, and professional services [S19], with 8.4% of total effects. Relevant are also the effects on machinery and equipment [S9], with 6.3%.

In terms of employment, we showed that the short-term demand-side effects are negative. They represent -36.5% of total long-term accumulated effects. In turn, long-term effects in the construction industry [S12] represent 73.6% of the total employment effect. Accordingly, the net demand-side effects on employment is 37.1%. The remaining long-term effects are 62.9%. These are mostly concentrated in long-term operation purposes – professional services [S19], with 50.4%, and transportation [S14], with 4.9% of total effects. But also long-term functional channels – machinery [S9], with 6.8%, and basic metals [S8], with 6.0%.

Finally, in terms of private investment, we showed that short-term demand-side effects are 73.8% of the total effects. These are concentrated in industries such as electricity [S10], water [S11], construction [S12], transportation [S14], finance [S17], and professional services [S19]. In turn, the long-term construction [S12] effects are 2.9%. Overall, the demand-side effects are 76.7%. The remaining long-term effects, 23.3%, are found among long-term operation channels – water [S11], with 5.5%, and professional services [S19], with 4.7%. Long-term functional channels relating to machinery and equipment [S9] represent 6.3%, and trade [S13], with 3.5%, are also important.

5.5. On the Effects of Health Care Investments on the Industry Mix

In Table 6 we reframe our results to determine how the industry mix in the country is affected by health investments. We focus on the effects of health investments in relative terms, i.e., we go beyond the long-term marginal products and focus on the magnitude of these effects, relative to the size of each industry. For example, two industries can exhibit precisely the same marginal product in terms of investment, but if the share of the first in overall gross fixed capital formation is much larger than that of the second, then health care investments are deemed to have an impact that is far more significant in the latter. Such a case would be captured in Table 6 by a big ratio, computed, industry by industry, as the relationship between the share of benefits and the share of investment. In general, a ratio above one implies that health investments affect the industry more than its relative size and that, therefore, health investments tend to increase its share in the industry mix in the country.

First, in terms of output, we find that the top three beneficiaries with the highest ratios are real estate [S18], construction [S12], and transportation and storage [S14]. Non-metallic minerals [S7], machinery and equipment [S9] and professional services [S19] also benefit relatively more than their output share. In all of these industries, the output share will increase, as a result of health investments. The opposite is true for all the remaining industries.

Analogously, when we turn our attention to employment, the three industries with the highest ratios are professional services [S19], construction [S12], and basic metals [S8], followed by chemical and pharmaceutical [S6], non-metallic minerals [S7] and machinery and equipment [S9]. In these industries, employment shares will rise as a result of health care investments. At the opposite side of the spectrum – i.e., in terms of net job destruction – the three leading industries are health care [S22], agriculture [S1], and textiles [S4]. Health investments set in motion a reallocation of workers, and these results help identify the main industries that will downsize, as well as the industries that will be hiring.

In terms of the total accumulated effects on private investment, the industries with the highest ratios are water [S11] and finance [S17]. Other industries that benefit in relative terms are non-metallic minerals [S7], basic metals [S8], electricity and gas [S10], construction [S12], trade [S13], and professional services [S19].

Overall, non-metallic minerals [S7], construction [S12] and professional services [S19] are the only industries that benefit in relative terms in the three dimensions considered – output, employment, and investment – and, therefore, increase their relative share in the industry mix along these three dimensions. In turn, basic metals [S8] and machinery and equipment [S9], benefit in relative terms along two of the three dimensions.

6. Summary and Concluding Remarks

In this paper we set out to identify the economic-performance effects of health care investments in Portugal. Using a newly-developed data set and a vector-autoregressive model, we estimate both the elasticity and the marginal product of capital spending in health care on output, employment and private investment at the industry level.

Our main conclusions can be summarized as follows. At the most aggregate level, an investment in the health care industry has very significant positive spillover effects, expanding GDP, creating jobs, and inducing further investment. On the negative side, net exports deteriorate, the flip-side result of an increase of gross fixed capital formation that outstrips the increase in GDP. We estimate that a health care investment worth €1 million boosts overall investment and GDP by €24.74 and €20.45 million, respectively, and further creates an additional 188 jobs.

At a disaggregated level, our analysis suggests that real estate, construction, and transportation and storage are the three industries that jointly account for 77% of the increase in GDP, closely followed by professional services and by machinery and equipment. The industries where most jobs are created for every one million euros of investment in the health care industry, by decreasing order of significance, include professional services, construction, basic metals, transportation and storage, and machinery and equipment. In terms of the industry-specific total accumulated marginal products on investment, water, real estate, and finance jointly account for around 40% of the overall increase in gross fixed capital formation, closely followed by professional services, public administration, and electricity and gas with around 30%.

These effects have repercussions in terms of the industry composition of output, employment, and private investment in the country. We find that non-metallic minerals, construction, and professional services are the only industries that benefit in relative terms in the three dimensions considered, while basic metals and machinery and equipment benefit in relative terms along two of the three dimensions.

Finally, we find that, only 28.2% of the total accumulated increase in GDP occurs in the short run. Although most of the increase in overall investment is frontloaded, with 73.8% of this taking place within one year, in the short run, following a €1 million investment in the health care industry, 68 workers are displaced, even though, in time, 256 permanent jobs are then created.

There are some important policy implications of these results. First, with large positive effects on output, employment, and private investment, health care investments are very effective in promoting long-term economic performance and employment. Second, with long-term effects accounting for the bulk of the GDP gains and with short-term employment losses, these results clearly suggest that health care investments are not particularly useful counter-cyclically.

Third, our results also give us a clear sense of the channels through which economic performance is affected. Demand-side effects, approximated by the sum of the short-term effects as well as long-term construction effects, are very important, in particular for private investment. In turn, long-term effects that seem to be related to the operation channel – transportation and professional services – are also very relevant. Long-term location effects are particularly significant in the case of output – about one fourth of the total effects. Long-term functional effects on heavy industry – non-metallic, basic metals, and machinery and equipment – are also quite meaningful.

Fourth and finally, the decision to invest in health care is not neutral from the standpoint of the industry mix. It is tantamount to picking winners and losers. Indeed, the implications in terms of the traded/non-traded industry divide are clear. We see that non-traded service industries – the likes of construction and professional services – are the largest beneficiaries in relative terms from health investments. Furthermore, we find that traded industries such as non-metallic minerals, basic metals, and machinery and equipment also benefit in an important manner, albeit to a smaller extent. For all of these industries, health care investments increase their relative importance in the country's industry mix.

We conclude by making reference to three promising avenues of future research. Notwithstanding both the wealth and the variety of the empirical results presented in this article, there are three refinements that would further enhance the analysis. They would all require an even more detailed data set which is, as yet, unavailable. First, and most importantly, the distinction between public and private investments in the health care industry. This would allow us to add the effects on the public budget to the economic variables we already considered. Second, splitting capital spending in the health care industry between equipment and infrastructure would also allow us to answer the question about which of these two is relatively more significant in terms of its effect on economic performance. Third, it would be interesting to investigate whether or not there are significant cross-regional differences in the effects of health care investments, both in terms of the spillover effects of investments in one region upon surrounding regions, and in terms of deciding upon the best location of such investments.

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Table 1. Health Care Investments

	1980-2009	1980-89	1990-99	2000-09
Health Care Investment as a share of GDP (%)	0.55	0.34	0.57	0.75
Health Care Investment as a share of Infrastructure Investment (%)	10.74	9.89	10.73	11.97
Infrastructure Investment as a share of GDP (%)	4.18	2.88	4.40	5.04

Source: [2].

Table 2. Industry Classification by Sector

Primary Sector	
Agriculture (S1)	Agriculture, forestry and fishing;
Mining (S2)	Mining and quarrying;
Secondary Sector: Manufacturing	
Food (S3)	Manufacture of food products, beverages and tobacco products;
Textiles (S4)	Manufacture of textiles, wearing apparel and leather products;
Paper (S5)	Manufacture of wood and paper products, and printing;
Chemical and pharmaceutical (S6)	Manufacture of coke, refined petroleum products and fuels; Manufacture of chemicals and chemical products; Manufacturing of basic pharmaceutical products and pharmaceutical preparations;
Non-metallic minerals (S7)	Manufacture of rubber and plastics products, and other non-metallic mineral products;
Basic metals (S8)	Manufacture of basic metals and fabricated metal products, except machinery and equipment;
Machinery and equipment (S9)	Manufacture of computer, electronic and optical products; Manufacture of electrical equipment; Manufacture of machinery and equipment; Manufacture of transport equipment; Manuf. of furniture; Other manufacturing; Repair and installation of machinery and equipment;
Tertiary Sector: Private Services	
Electricity and gas (S10)	Electricity, gas, steam and air-conditioning supply;
Water (S11)	Water, sewage, waste management and remediation activities;
Construction (S12)	Construction;
Wholesale and retail trade (S13)	Wholesale and retail trade; Repair of motor vehicles;
Transportation and storage (S14)	Transportation and storage;
Hospitality (S15)	Accommodation and food service activities;
Telecommunications (S16)	Telecommunications;
Finance (S17)	Financial and insurance activities;
Real estate (S18)	Real-estate activities;
Professional services (S19)	Publishing, audiovisual and broadcasting activities; Computer programming, consultancy and related activities; Information-service activities; Legal and accounting activities; Activities of head offices; Management consultancy activities; Architecture and engineering activities; Scientific research and development; Advertising and market research; Other professional, scientific and technical activities; Veterinary activities; Admin. and supp. service activities; Arts, entertainment and recreation;
Tertiary Sector: Public Services	
Public administration (S20)	Public administration and defense; Compulsory social security;
Education (S21)	Education;
Health (S22)	Human health services; Social work activities;

Source: Classification of Economic Activities (CAE, Rev. 3), [63].

Table 3. Industries' Share of GDP [a]

	1978-2009	1980-89	1990-99	2000-09
Agriculture and Mining	**8.6**	**14.1**	**6.6**	**3.4**
Agriculture (S1)	6.7	10.2	5.6	2.9
Mining (S2)	1.9	3.9	1.0	0.5
Manufacturing	**18.1**	**20.5**	**18.5**	**15.1**
Food (S3)	2.1	2.0	2.2	2.1
Textiles (S4)	3.7	4.2	4.2	2.7
Paper (S5)	2.2	2.4	2.2	1.8
Chemical and pharmaceutical (S6)	1.7	2.3	1.5	1.2
Non-metallic minerals (S7)	2.7	3.4	2.6	2.0
Basic metals (S8)	2.5	3.5	2.1	1.8
Machinery and equipment (S9)	3.3	2.7	3.7	3.7
Private Services	**56.3**	**52.7**	**56.7**	**60.3**
Electricity and gas (S10)	2.1	1.8	2.4	2.2
Water (S11)	0.6	0.5	0.6	0.9
Construction (S12)	7.1	6.8	7.0	7.7
Wholesale and retail trade (S13)	15.4	16.8	15.1	14.1
Transportation and storage (S14)	4.6	5.2	4.3	4.6
Hospitality (S15)	3.7	2.7	3.9	4.7
Telecommunications (S16)	1.9	1.4	2.0	2.3
Finance (S17)	6.3	6.3	6.1	6.6
Real estate (S18)	7.5	6.0	7.4	8.0
Professional services (S19)	7.2	5.2	7.8	9.1
Public Services	**17.0**	**12.8**	**18.2**	**21.2**
Public administration (S20)	8.5	7.2	8.9	9.9
Education (S21)	5.3	3.6	6.0	6.8
Health (S22)	3.2	2.0	3.3	4.5
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: [1].

[a] Totals may not add up due to rounding errors.

Table 4. Total Industry-Specific Effects of Health Care Investments [a]

	Elasticity			Marginal Product		
	Investment	**Employment**	**Output**	**Investment**	**Employment**	**Output**
Total Economy				**24.74**	**187.55**	**20.45**
Agriculture and Mining						
Agriculture (S1)	0.097*	-0.045	-0.064*	*	-52.55	*
Mining (S2)	-0.718*	-0.065*	0.133*	*	*	*
Manufacturing						
Food (S3)	0.088*	-0.011*	-0.050*	*	*	*
Textiles (S4)	0.302	-0.019	-0.033*	0.19	-12.78	*
Paper (S5)	0.084*	0.003*	0.072	*	*	0.41
Chemical and pharm. (S6)	0.534	0.030	-0.065*	0.32	1.72	*
Non-metallic minerals (S7)	0.497	0.063	0.151	0.68	13.89	0.94
Basic metals (S8)	0.418	0.102	0.094*	0.37	25.46	*
Machinery and equipment (S9)	0.158*	0.033	0.165	*	15.50	1.93
Private Services						
Electricity and gas (S10)	0.605	0.050	-0.183*	1.98	1.48	*
Water (S11)	1.737	-0.001*	-0.243	3.43	*	-0.68
Construction (S12)	0.574	0.071	0.242	2.03	97.68	5.93
Wholesale and retail trade (S13)	0.458	0.008*	0.015*	2.46	*	*
Transportation and storage (S14)	-0.031*	0.038	0.227	*	15.79	3.31
Hospitality (S15)	0.232*	-0.023*	-0.004*	*	*	*
Telecommunications (S16)	-0.387*	-0.041	-0.026*	*	-1.62	*
Finance (S17)	1.033	0.029*	0.084*	3.25	*	*
Real estate (S18)	0.142	0.059*	0.261	3.31	*	6.64
Professional services (S19)	0.374	0.074	0.067	3.10	102.08	1.97
Public Services						
Public administration (S20)	0.283	-0.032*	-0.027*	2.52	*	*
Education (S21)	0.158*	0.013*	-0.001*	*	*	*
Health (S22)	0.317	-0.022	-0.029*	1.10	-19.10	*

[a] The estimates marked with an asterisk (*) are not significantly different from zero, as implied by the standard deviation bands. Also, totals may not add up due to rounding errors. Aggregates and total marginal products for each sector are the sum of the statistically-significant constituent industry-specific effects.

Table 5. Long-Term Marginal Products versus Effects upon Impact [a]

		Investment	Employment	Output
Total Economy	Total Effect	24.74	187.55	20.45
	Short Term	18.26	-68.48	5.77
Agriculture and Mining				
Agriculture (S1)	Total Effect	*	-52.55	*
	Short Term	*	-35.34	*
Mining (S2)	Total Effect	*	*	*
	Short Term	*	*	*
Manufacturing				
Food (S3)	Total Effect	*	*	*
	Short Term	*	*	*
Textiles (S4)	Total Effect	0.19	-12.78	*
	Short Term	0.00	-13.07	*
Paper (S5)	Total Effect	*	*	0.41
	Short Term	*	*	0.49
Chemical and pharmaceutical (S6)	Total Effect	0.32	1.72	*
	Short Term	0.09	1.02	*
Non-metallic minerals (S7)	Total Effect	0.68	13.89	0.94
	Short Term	0.14	6.56	0.49
Basic metals (S8)	Total Effect	0.37	25.46	*
	Short Term	0.16	14.21	*
Machinery and equipment (S9)	Total Effect	*	15.50	1.93
	Short Term	*	2.78	0.63
Private services				
Electricity and gas (S10)	Total Effect	1.98	1.48	*
	Short Term	1,81	1.13	*
Water (S11)	Total Effect	3.43	*	-0.68
	Short Term	2.07	*	-0.86
Construction (S12)	Total Effect	2.03	97.68	5.93
	Short Term	1.31	-40.35	1.99
Wholesale and retail trade (S13)	Total Effect	2.46	*	*
	Short Term	1.60	*	*
Transportation and storage (S14)	Total Effect	*	15.79	3.31
	Short Term	*	6.55	1.15
Hospitality (S15)	Total Effect	*	*	*
	Short Term	*	*	*
Telecommunications (S16)	Total Effect	*	-1.62	*
	Short Term	*	-1.42	*
Finance (S17)	Total Effect	3.25	*	*
	Short Term	3.43	*	*
Real estate (S18)	Total Effect	3.31	*	6.64
	Short Term	2.61	*	1.63
Professional services (S19)	Total Effect	3.10	102.08	1.97
	Short Term	1.95	7.64	0.25
Public services				
Public administration (S20)	Total Effect	2.52	*	*
	Short Term	1.96	*	*
Education (S21)	Total Effect	*	*	*
	Short Term	*	*	*
Health (S22)	Total Effect	1.10	-19.10	*
	Short Term	1.12	-18.20	*

[a] Short- and long-term marginal products for the economy as a whole are the sum of the respective statistically-significant industry-specific effects.

Table 6. Effects of Health Care Investments on the Composition of Economic Activity [a]

	Investment				Employment				Output			
	Marginal Product	Share of Benefits	Share of GFCF	Ratio	Marginal Product	Share of Benefits	Share of Empl.	Ratio	Marginal Product	Share of Benefits	Share of Output	Ratio
Agriculture (S1)	*	*	3.8	*	-52.55	-28.02	14.5	-1.93	*	*	6.7	*
Mining (S2)	*	*	1.0	*	*	*	1.0	*	*	*	1.9	*
Food (S3)	*	*	1.4	*	*	*	2.7	*	*	*	2.1	*
Textiles (S4)	0.19	0.76	1.3	0.58	-12.78	-6.81	7.4	-0.92	*	*	3.7	*
Paper (S5)	*	*	1.4	*	*	*	2.3	*	0.41	2.00	2.2	0.91
Chemical and pharmaceutical (S6)	0.32	1.29	2.0	0.65	1.72	0.92	0.8	1.15	*	*	1.7	*
Non-metallic minerals (S7)	0.68	2.75	2.0	1.38	13.89	7.41	2.0	3.71	0.94	4.60	2.7	1.70
Basic metals (S8)	0.37	1.50	1.1	1.37	25.46	13.58	2.3	5.90	*	*	2.5	*
Machinery and equipment (S9)	*	*	4.0	*	15.50	8.26	4.0	2.07	1.93	9.44	3.3	2.86
Electricity and gas (S10)	1.98	8.00	4.9	1.63	1.48	0.79	4.3	0.18	*	*	2.1	*
Water (S11)	3.43	13.86	3.4	4.08	*	*	0.4	*	-0.68	-3.33	0.6	-5.55
Construction (S12)	2.03	8.20	5.3	1.55	97.68	52.08	0.9	57.87	5.93	29.00	7.1	4.08
Wholesale and retail trade (S13)	2.46	9.94	5.6	1.78	*	*	10.7	*	*	*	15.4	*
Transportation and storage (S14)	*	*	5.8	*	15.79	8.42	13.9	0.61	3.31	16.19	4.6	3.52
Hospitality (S15)	*	*	1.9	*	*	*	3.5	*	*	*	3.7	*
Telecommunications (S16)	*	*	2.7	*	-1.62	-0.86	4.4	-0.20	*	*	1.9	*
Finance (S17)	3.25	13.14	4.8	2.74	*	*	0.4	*	*	*	6.3	*
Real estate (S18)	3.31	13.38	26.6	0.50	*	*	2.3	*	6.64	32.47	7.5	4.33
Professional services (S19)	3.10	12.53	6.7	1.87	102.08	54.43	0.5	108.86	1.97	9.63	7.2	1.34
Public administration (S20)	2.52	10.19	10.8	0.94	*	*	8.0	*	*	*	8.5	*
Education (S21)	*	*	1.7	*	*	*	5.7	*	*	*	5.3	*
Health (S22)	1.10	4.45	1.9	2.34	-19.10	-10.18	3.8	-2.84	*	*	3.2	*
	24.74	100.0	100.0		187.55	100.0	100.0		20.45	100.0	100.0	

[a] The estimates marked with an asterisk (*) are not significantly different from zero, as implied by the standard deviation bands. Also, totals may not add up due to rounding errors. Shares of benefits are computed using the sum of the statistically-significant industry-specific marginal products.