EL COLEGIO DE MÉXICO
CENTRO DE ESTUDIOS ECONÓMICOS

MAESTRÍA EN ECONOMÍA

TRABAJO DE INVESTIGACIÓN PARA OBTENER EL GRADO DE MAESTRO EN ECONOMÍA

THE MACROECONOMIC EFFECTS OF HEALTHCARE IN THE PRESENCE OF A LARGE INFORMAL ECONOMY

EMMANUEL MARURI SALINAS

PROMOCIÓN 2019-2021

ASESOR:

STEPHEN MCKNIGHT

JULIO, 2021

This page is intentionally left blank.

A mis padres,
Miguel y Rosalba.

Acknowledgments

Este trabajo representa el fin de un ciclo importante en mi carrera profesional, por lo que aprovecho un pequeño espacio para agradecer a quienes me han ayudado a llegar hasta aquí. Por cuestiones de espacio, no están todos los que son, pero son todos los que están.

Para empezar, expreso mi más sincero agradecimiento a mis padres, Miguel y Rosalba, quienes, dentro de sus limitaciones, me han apoyado todo lo posible para alcanzar mis metas. Lo que he logrado hasta aquí, y lo que logre en adelante, por mucho o poco que sea, es y será gracias a su esfuerzo y apoyo incondicionales.

Agradezco a todos y cada uno de mis compañeros de generación de la maestría por su camaradería. Gracias por ser quienes son, por ayudarme a descubrir nuevas ideas y por impulsarme a ser mejor cada día. En especial, agradezco a Diego y Níobe por su apoyo durante toda esta aventura, por acompañarme durante incontables noches de desvelo y por preocuparse por mí, sin ustedes no habría llegado hasta el final y no estaría escribiendo estas palabras.

Gracias también a mis compañeras del propedéutico Catalina, Jazmín y Vania, pues aunque fue poco el tiempo en que pudimos convivir, siempre me apoyaron a su manera para seguir adelante.

Agradezco a El Colegio de México, por ser una institución ejemplar dentro de la educación pública mexicana y por darme la oportunidad de continuar mi formación como economista dentro de sus aulas (aunque más de la mitad del programa terminó siendo en línea). Gracias a todo el personal que trabaja en el colegio por hacer de mi estancia ahí sumamente amena, tanto al personal administrativo, como al de la biblioteca, al del comedor y al de limpieza.

Gracias a todos los profesores del Centro de Estudios Económicos por su tiempo, paciencia y sabiduría, conocerlos y aprender de ustedes ha sido todo un reto y al mismo tiempo un placer. En particular, gracias al profesor Stephen McKnight por ser mi asesor de tesis. Muchas veces me sentí perdido o abrumado durante este proyecto, pero usted siempre estuvo ahí para darme un poco de luz y orientarme. Otra vez, gracias.

Finalmente, agradezco a Ana por ser mi compañera de aventura y por creer siempre en mí.

Abstract

We propose a dynamic general equilibrium model to analyze the relationship between health, the employment situation (formal or informal), and the business cycle. In our setting, households choose how much labor to allocate to formal and informal activities and accumulate a health capital stock that can be improved by medical expenditures but depreciates with labor. Formal firms have to pay taxes but enjoy higher productivity levels. Informal producers are less productive but do not pay taxes. Three different medical providers, one private and two public, operate in a perfectly competitive industry. The government taxes personal income and the hiring of labor by formal firms, and its expenditures comprise purchases in formal goods and subsidies to the medical consumption of households.

After parameterizing the model for the Mexican economy, we found that in response to a positive formal productivity shock, households find it optimal to invest in their health not through higher spending on medical services but through a reduction in working time. When a positive health capital investment shock occurs, medical inputs productivity rises, and households reduce their labor time to increase health investment, prompting a reallocation of resources from the labor market to the medical sector. In case of a positive cost shock in a medical services firm, the resulting increase in prices implies a reduction in the accumulation of health capital which implies a reallocation of resources to the formal sector of the economy since the increased cost of health capital investment can be compensated by hiring physical capital. The robustness of the model is tested via a sensitivity analysis, which suggests that our results hold for empirically plausibly parameters.

Contents

List of Figures

Introduction

There is a growing body of literature that has tried to systematically investigate the aggregate response to shocks to various medical consumption determinants. Papers such as those by Hall and Jones (2007), Huang and Huffman (2014), He, Huang, and Hung (2016), and Kelly (2017) have suggested different ways of approaching this problem. However, these studies are based on the United States, so that do not consider distinctive elements of emerging economies. One of these elements is informality, which not only represents a considerable component of the aggregate economy but is also closely related to health financing. For example, according to Medina and Schneider (2018), the average size of the informal economy in Mexico was 32% as a percentage of the national GDP during 1991-2015. In Bolivia, this number reaches up to 62%.

Like many other developing countries, Mexico has social insurance with a dual structure, segmented mainly by labor status, particularly whether a worker is formal or informal. Social insurance typically includes a bundle of benefits like health, work-risk, death and disability insurance, and retirement pensions, among others. The benefits and the method of financing (a tripartite scheme, i.e., with contributions from firms, workers, and the government) are usually referred to as "contributory social insurance." Recently, many countries have created or expanded health, pension, and related programs paid from general revenues and thus are referred to as "noncontributory social insurance" (Levy & Schady, 2013).

If we focus on the health system, things are similar. For example, in México, public and private institutions interact in the health system. On the public side of the sector, there are social security institutions and the services provided by the Ministry of Health (Secretaria de Salud). The main social security institutions are the Mexican Institute of Social Security (IMSS), with almost 62 million members (51% of the population), and the Institute of Social Security and Services for State Workers (ISSSTE), with nearly 13 million (11% of the population). With a view to the universalization of health services, the General Health Law was reformed in 2003, and the Social Protection System in Health was created, whose operating arm was the Seguro Popular, which as of June 2017 registered over 53 million affiliates.[1]

On the private side of the health system, there are several service providers in clinics, pri-

[1]Despite these public institutions, the 2016 National Health and Nutrition Survey (ENSANUT) found that just over 13% of those surveyed lack health protection.

vate hospitals, and pharmacies. It is worth noting that the quality and safety of private services are heterogeneous (Instituto Mexicano para la Competitividad, 2018). Only 7% of the Mexican population gets private insurance, so many of the medical services patients pay for the services directly (which is known as out-of-pocket medical spending). In fact, workers who contribute directly to the payment of their social security and have health insurance resort to private medical services, either because they consider it to be of higher quality or because of the saturation of the medical services provided by the state. In Mexico, the medical spending in private institutions as a share of total national spending on medical services of some kind was 52.8% on average between 1993 and 2017.[2]

In order to analyze the macroeconomic implications of the relationship between informality, social insurance financing, and health spending, we develop a two-sector dynamic general equilibrium model that allows for endogenous health accumulation and labor supply in the formal and informal labor markets. In the model, households choose how much labor to allocate to each market and consume formal and informal goods produced in each sector. They accumulate a health capital stock that can be improved by medical expenditures but depreciates with labor and exogenous forces. Also, households accumulate physical capital which is rented to formal firms. Formal firms have a constant returns to scale technology whereas the informal sector is assumed to be self-employed and operates with a decreasing returns to scale technology. Formality entails costs and benefits. Formal firms have to pay taxes on the wage bill but enjoy higher productivity levels. Informal producers are less productive but do not pay taxes. Health stock works as a production input in both sectors. There are three different medical providers, one private and two public, that operates in a perfect competitive industry. The government taxes personal income (wages and capital rents) and the hiring of labor by formal firms. Its expenditures comprises government purchases in formal goods and subsides to the medical consumption of households.

There are many sources of uncertainty in the model. First, there is a shock to the aggregate productivity in the formal sector. Following Fernández and Meza (2015), shocks to the formal sector are passed through to the informal sector. However, we assume an imperfect propagation of these shocks from the formal to the informal sector.Second, we allow for a health investment productivity shock. Third, we consider shocks to the cost function of each medical provider.

We show that in the face of a formal productivity shock with imperfect pass-through to the informal sector, households find it optimal to invest in their health not through higher spending on medical services but through a reduction in working time in both the formal and informal sectors. This effect happens when the increase in the real wage due to productivity shock is not sufficient to compensate the marginal loss in health for greater formal working time, so households choose to invest in health capital by working less.

Concerning the health capital investment shock, our model does a reasonably good job of

[2]Own calculation using data from SICUENTAS.

replicating the increase in medical expenditure carefully studied in the literature. In this case, we obtain the traditional transmission mechanism, i.e., as medical inputs become more productive, households reduce their labor time to increases health investment. This effect increases formal and informal output but with a reallocation of resources from the labor market to the medical sector. Government non-medical consumption decreases to finance the greater demand for public medical services.

Finally, we show that when a positive cost shock occurs in a medical services firm, the demand for goods for that firm is reduced, and the demand of other medical goods increases. This result follows from the perfect substitutes production function that we have assumed. The increase in the price of medical services implies a reduction in the accumulation of health capital, which reduces the marginal productivity of labor and physical capital, forcing people to work more in the formal sector even when the real wage has been reduced. Likewise, in the informal sector, the increased cost of investment in health generates an increase in the labor factor to compensate for the gradual reduction in health capital. These effects imply a reallocation of resources to the formal sector of the economy since the increased cost of health capital investment can be compensated by hiring physical capital.

Our research is closely related to a series of theoretical and empirical studies that delve into various dimensions of the relationship between health and macroeconomic performance. One of the most important questions in this area has been to try to elucidate the reasons behind the significant increase in spending on medical services as a proportion of aggregate production. Studies such as Hall and Jones (2007) have suggested that this is a consequence of the optimal response of economic agents to increasing income levels rather than a consequence of the technical progress of medical goods. The intuition for this result is that people become saturated in non-health consumption in any given period, driving its marginal utility to low levels. As people get richer, the most valuable channel for spending is to purchase additional years of life. These authors predict that health spending will rise more than 30 percent of GDP by the year 2050, compared to the observed level in 2000 of about 15 percent.

Based mainly on the empirical facts documented by Ruhm (2000), such as a procyclical of health spending and a countercyclical mortality rate, this literature gave rise to a more recent one that tries to analyze the relationship between the business cycle and health. Works such as He, Huang, and Hung (2014) and He et al. (2016) have proposed the use of dynamic general equilibrium models that incorporate health capital accumulation to help account for these facts. Recent studies have developed dynamic general equilibrium models to consider the role of different financing schemes (Huang & Huffman, 2014; Kelly, 2017) and differences in people's health (Kelly, 2020).

One dimension that this literature has not yet addressed is the relationship between health, the employment situation (formal or informal), and the business cycle. There is a growing literature that investigates the role of informality in explaining emerging market business cycles, such as Restrepo-Echavarria (2014), Fernández and Meza (2015), Horvath (2018), and Leyva and Urrutia (2020). The aim of this thesis is to introduce informality into a dynamic general equilibrium model with endogenous health capital accumulation and social insurance to analyze some of these relationships.

The thesis is structured as follows. In the following chapter, we present in detail the model. Chapter 2 presents the model in its log-linearized version and later discusses the choice of each of the necessary parameters. Chapter 3 presents the results of the model. First, the most relevant findings of this are listed, and then a sensitivity analysis is carried out to test the robustness of the results against different eligible parameters. At the end of the chapter, we compare the results obtained with those existing in the previous literature. The final chapter concludes.

Chapter 1

Model

This chapter develops a model to systematically investigate the aggregate response to shocks to various medical consumption determinants. As we mention in the introduction, many works have tried to address this question from different perspectives, but most of those studies are based on the United States, so none consider distinctive elements of emerging economies. For this reason, the model that we propose incorporates informal employment and the primary sources of health financing consistent with countries like Mexico.

As Levy and Schady (2013) document, many developing countries have social insurance (SI) with a dual structure, segmented mainly by labor status, particularly whether a worker is salaried or nonsalaried. On the one hand, contributory social insurance (CSI) typically includes a bundle of benefits like health, work-risk, death and disability insurance, and retirement pensions. This SI arrangement is usually financed by a tripartite scheme, where firms, workers, and government make contributions. On the other hand, there is the noncontributory social insurance (NCSI) paid by the government's general revenues and includes health, pension, and related programs depending on the country.

According to several estimates using different definitions of informality documented by Fernández and Meza (2015), between 20 and 42 percent of the labor force in Mexico was informal on average from 1987 to 2010. One of those definitions, useful for this work, is employment from wage earners who do not receive benefits provided by contributory social insurance, which reach 23% of the labor force on average in the same period. This sizable share of informal workers, together with the dual structure of social security, implies that a considerable part of the population, particularly those who have access to NCSI, do not pay directly for the medical services they receive but are financed by the government through different mechanisms. This arrangement does not mean that the government finances all spending on medical services, but rather that it coexists with the considerable out-of-pocket spending of Mexican households, as mentioned in the introduction. For this reason, the model that we propose incorporates informal employment with those different sources of health financing. For simplicity, in what follows we assume that social insurance only includes health services, and then we try to model the tripartite scheme of financing.

The main components of the model are summarized as follows. The economy is comprised of households, formal firms, medical firms, and a government. The economy is populated by a continuum of infinitely-lived households who allocate their time between leisure and formal and informal work activities, consume formal and informal goods, and accumulate capital to be rented by formal firms. Formal workers gain health insurance for medical expenditures, whereas informal workers do not. Their actions are influenced by health in an intertemporal way such that present decisions have consequences for the future through a capital stock for health, as Grossman (1972) first suggested.[1] Competitive formal firms produce goods that can be used for consumption or investment. Households produce informal goods that can be used only for consumption purposes inside the same sector. The three remaining goods are for medical purposes; these are supplied by different firms, one private and two related to public social insurance. Formal firms pay taxes, while informal firms do not. The government collects taxes, pays a fraction of the household's medical expenses through transfers, and is assumed to run a balanced budget in every period.

1.1 Representative Household

The representative household owns a time endowment equal to one to spend in leisure l_t and work in the formal (n_t^F) and informal (n_t^I) sectors, i.e. $1 = n_t^F + n_t^I + l_t$. In what follows, the superscripts F, I, and A denote formal, informal, and aggregate (formal plus informal) variables, whereas the superscripts PT, C, and NC denote private, contributory and noncontributory social insurance, respectively.

1.1.1 Health

Following He et al. (2016) and Kelly (2017), we assume that households can invest in their health stock h_t by buying medical goods provided by the private sector m_t^{PT}, the contributory social insurance m_t^C or the noncontributory social insurance m_t^{NC} given a health production technology $H(m_t^{PT}, m_t^C, m_t^{NC})$. This production function allows certain medical goods to generate more health than others to reflect the quality differences between them. In fact, the CSI and NCSI schemes are excluding, which means that a worker cannot receive grants from both services simultaneously. However, inside the same household, both schemes can coexist, and this fact allows us to maintain the representative household setting.

[1] In line with previous research on business cycles and health, we do not consider education as part of the human capital even though there is strong evidence about the importance of this factor to improve people's health during the last century (Cutler, Deaton, & Lleras-Muney, 2006). However, in future work, we could analyze the interaction between those variables.

The stock of health has two sources of depreciation, a natural rate of aging $\delta_h \in (0,1)$ and an endogenous component that is a function of working hours $D(n_t^F, n_t^I)$. Consequently, the law of motion for the health capital stock is given by:

$$h_{t+1} = H(m_t^{PT}, m_t^C, m_t^{NC}) + \left[1 - \delta_h - D(n_t^F, n_t^I)\right] h_t \tag{1.1}$$

1.1.2 Physical capital accumulation

Households accumulate physical capital according to the law of motion:

$$k_{t+1} = i_t + (1 - \delta_k) k_t, \tag{1.2}$$

where k_t is the capital stock at the beginning of period t, i_t is the investment flow, and $\delta_k \in (0,1)$ is the depreciation rate of capital.

1.1.3 Informal sector

Similar to Restrepo-Echavarria (2014), we assume that the informal sector of the economy is identical to household production. As discussed by Fernández and Meza (2015), self-employment is a good proxy for the informal economy in Mexico. Households can freely choose the amount of work in the informal sector, where the representative household has access to production technology given by:

$$y_t^I = f^I(n_t^I, h_t; z_t^I) \tag{1.3}$$

where y_t^I is the informal sector's production at time t and z_t^I is a contemporaneous productivity shock specific to the informal sector. Note that production is a function of health (the same is true for the formal technology), a common assumption in this literature.

1.1.4 Budget constraint and preferences

The period budget constraint of the representative household is given by:

$$c_t^F + i_t + p_t c_t^I + p_t^{PT} m_t^{PT} + (1 - \theta_C) p_t^C m_t^C + (1 - \theta_{NC}) p_t^{NC} m_t^{NC} = p_t y_t^I + (w_t n_t^F + r_t k_t)(1 - \tau_y) \tag{1.4}$$

where c_t^F is the consumption of formal goods at time t, c_t^I is the consumption of informal goods, p_t is the price of informal goods relative to formal goods, analogously p_t^x is the price of medical good $x \in PT, C, NC$ relative to formal goods, w_t is the real wage in the formal sector, r_t is the rental price of the capital stock, τ_y is the income tax, and θ_C and θ_{NC} represent the fraction of medical expenditures financed by contributory and noncontributory social insurance, respectively. The differences $1-\theta_C$ and $1-\theta_{NC}$ can be thought of as recovery fees for medical services.[2]

The representative household maximizes expected lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^A, n_t^A, h_t) \tag{1.5}$$

where $\beta \in (0,1)$ is the subjective discount factor and E_t is the mathematical expectation operator conditional on the information at time t. Aggregate employment is defined as:

$$n_t^A = n_t^F + n_t^I \tag{1.6}$$

and aggregate consumption in both sectors –excluding medical goods– is given by:

$$c_t^A = \left[\zeta (c_t^F)^{\mu} + (1-\zeta)(c_t^I)^{\mu}\right]^{1/\mu} \tag{1.7}$$

where $\zeta \in (0,1)$ is the share parameter of formal consumption relative to aggregate consumption and $1/(1-\mu)$ is the elasticity of substitution between formal and informal goods.

1.2 Representative Formal Firm

Formal firms hire labor and capital in competitive markets and pay a tax on the wage bill τ_c for SI purposes (expressed as a proportion of the wage). This tax captures both firms' contribution to social insurance and the fee to formal workers through the distortion on wages.[3] Following Antón et al. (2012), we add the parameter $\eta \in [0,1]$ to represent the government's contribution to financing the CSI.

The representative formal firm solves the problem

$$\max_{k_t, n_t^F} \Pi_t^F = y_t^F - r_t k_t - [1 + (1-\eta)\tau_c] w_t n_t^F \tag{1.8}$$

subject to production technology:

$$y_t^F = f^F(k_t, n_t^F, h_t; z_t^F) \tag{1.9}$$

where y_t^F is formal production at time t and z_t^F is a productivity shock specific to the formal sector.

It is important to note that one of the key differences between the formal and informal sectors relates to the level of productivity. Consistent with the empirical evidence, we follow Fernández and Meza (2015) and assume that formal firms are more productive than informal ones, to such an extent that this allows them to meet the costs of social security and still be profitable.

[2] In the case of Mexico, both the CSI and NCSI medical services are financed mainly by the government. However, in each case, some specific services demand a fee from the user, which in the aggregate is a minimum part of those institutions' income.

[3] This way to incorporate the labor taxes is a typical representation of the Mexican labor market, such as Fernández and Meza (2015) and Antón, Hernández, and Levy (2012).

1.3 Medical sector

We assume a medical industry with three firms: a private firm, a firm that provides the medical services for contributory social insurance, and a firm that provides the medical services for noncontributory social insurance. For simplicity, we assume perfect competition and no underwriting costs. The relative price of each medical good with respect to the price of non-medical goods is determined by equilibrium in the health care market.

Each medical provider $x \in \{PT, C, NC\}$ receives revenue from purchases of medical services and incurs costs, $d^x(m_t^x)$, so its objective function is defined as:

$$\max_{m_t^x} \Pi_t^x = p_t^x m_t^x - d^x(m_t^x). \tag{1.10}$$

1.4 Government

The government is assumed to run a balanced budget in every period, only consumes formal goods, and pays a fraction of household's medical expenditure through contributory and noncontributory social insurance. Government collects a tax on the wage bill from formal firms τ_c, of which it pays a fraction $(1-\eta)$ as a concept of the tripartite contribution to social insurance. Government also levies an income tax τ_y on households. Thus, the government budget constraint is given by:

$$(1-\eta)\tau_c w_t n_t^F + \tau_y(w_t n_t^F + r_t k_t) = g_t + \theta_C p_t^C m_t^C + \theta_{NC} p_t^{NC} m_t^{NC} \tag{1.11}$$

where g_t is the non-medical government spending. In order to achieve a balanced budget every period, g_t is the resources that remain after the government pays the subsidies for medical services to households.

1.5 Market clearing conditions

Market clearing in the formal sector requires:

$$y_t^F = c_t^F + i_t + g_t, \tag{1.12}$$

and for the informal sector

$$y_t^I = c_t^I. \tag{1.13}$$

In the medical sector, each firm sells everything it produces.

1.6 Functional forms

We assume that the health production technology $H(m_t^{PT}, m_t^C, m_t^{NC})$ is given by a perfect substitutes goods function:

$$H(m_t^{PT}, m_t^C, m_t^{NC}; z_t^m) = z_t^m \left(\xi_{PT} m_t^{PT} + \xi_C m_t^C + \xi_{NC} m_t^{NC} \right) \tag{1.14}$$

where z_t^m is a health investment productivity parameter and ξ_x is the share parameter of input $x \in \{PT, C, NC\}$, such that $\xi_{PT} + \xi_C + \xi_{NC} = 1$. The higher the value of ξ_x, the greater the marginal contribution of good x on health. Therefore, each medical good may have a different contribution to health to reflect the differences in quality between them.

This health production function is consistent with the empirical evidence found by Bayraktar-Sağlam (2017), whose results suggest that private and public health expenditures are complements for high-income OECD countries whereas they are substitutes for low and middle-income countries including Mexico.

The endogenous depreciation component $D(n_t^F, n_t^I)$ of health is given by:

$$D(n_t^F, n_t^I) = (n_t^F)^{\omega} (n_t^I)^{1-\omega} \tag{1.15}$$

where $\omega \in (0,1)$ determines the curvature of this function for both types of labor. The greater is ω, the greater the depreciation of health by formal work given a fixed amount of informal work.

The production functions in both sectors have the form

$$y_t^F = z_t^F (k_t)^{\alpha_F} (n_t^F h_t)^{1-\alpha_F} \tag{1.16}$$

$$y_t^I = z_t^I (n_t^I h_t)^{\alpha_I} \tag{1.17}$$

where z_t^x is the productivity shock specific to the sector $x \in \{F, I\}$, $\alpha_F \in (0,1)$ is the share of capital used as input in the production at formal sector, and $\alpha_I \in (0,1)$ determines the curvature of the informal production function.

The cost function of the three medical providers is given as:

$$d_t^x = a_t^x (m_t^x)^{\psi_x} \tag{1.18}$$

where a_t^x is a productivity shock specific to the firm x and ψ_x is the curvature parameter for medical care cost function, where $x \in \{PT, C, NC\}$. Of course, this parameter ψ_x can differ across firms.

We assume that the household receives utility from its non-medical consumption, leisure time, and health stock. We assume that the household's instantaneous utility function is separable between consumption and leisure

$$u(c_t^A, n_t^A, h_t) = \log(c_t^A h_t) - \gamma_n \frac{(n_t^A)^{1+\chi}}{1+\chi} \tag{1.19}$$

where γ_n determines the importance of leisure relative to consumption/health in preferences and χ is the parameter for the wage elasticity of labor.

This utility function is a special case of the utility function proposed by Picone, Uribe, and Mark Wilson (1998), with the risk aversion coefficient equal to unity. Note that this utility function (1.19) implies that consumption and health are complements, a well documented fact by Finkelstein, Luttmer, and Notowidigdo (2013).

The productivity shock in formal sector follows a conventional AR(1) process

$$\log z_t^F = \rho_F \log z_{t-1}^F + \varepsilon_t^F \tag{1.20}$$

where ε_t^F is an i.i.d. white noise process with mean zero and unit standard deviation and the parameter $\rho_F \in (-1,1)$ governs the serial correlation of technology shock.

Following Fernández and Meza (2015), we assume an incomplete pass-through of productivity shocks from the formal to the informal sector, given by:

$$z_t^I = (z_t^F)^{\kappa}(z_{t-1}^I)^{1-\kappa} \tag{1.21}$$

where $\kappa \in (0,1)$ measures the elasticity of this shock. The greater κ, the greater the degree formal shocks are passed through to the informal sector.

The shocks related with health also follows a conventional AR(1) process. Thus, the productivity shock in the health production is given by:

$$\log z_t^m = \rho_m \log z_{t-1}^m + \varepsilon_t^m, \tag{1.22}$$

where ε_t^m is an i.i.d. white noise process and the parameter $\rho_m \in (-1,1)$ represents the serial correlation of the shock. The processes of the cost shocks are given by:

$$\log a_t^{PT} = \rho_{PT} \log a_{t-1}^{PT} + \varepsilon_t^{PT}, \tag{1.23}$$

$$\log a_t^{C} = \rho_{C} \log a_{t-1}^{C} + \varepsilon_t^{C}, \tag{1.24}$$

$$\log a_t^{NC} = \rho_{NC} \log a_{t-1}^{NC} + \varepsilon_t^{NC}, \tag{1.25}$$

where, again, ε_t^x is an i.i.d. white noise process with mean zero and unit standard deviation and the parameter $\rho_x \in (-1,1)$ governs the serial correlation of each shock, with $x \in \{PT, C, NC\}$.

1.7 Household optimization

The Lagrangian of the household problem can be expressed as

$$\begin{aligned}
\mathscr{L} =& E_0 \sum_{t=0}^{\infty} \beta^t \{u(c_t^F, c_t^I, n_t^F, n_t^I, h_t) \\
&+ \lambda_{1t} \left[p_t f^I(n_t^I, h_t; z_t^I) + (w_t n_t^F + r_t k_t)(1-\tau_y) - c_t^F - (k_{t+1} - (1-\delta_k)k_t) - p_t c_t^I \right. \\
&\left. - p_t^{PT} m_t^{PT} - (1-\theta_C)m_t^C - (1-\theta_{NC})m_t^{NC}\right] \\
&+ \lambda_{2t} \left[h_{t+1} - H(m_t^{PT}, m_t^C, m_t^{NC}) - (1-\delta_h - D(n_t^F, n_t^I))h_t\right]\}
\end{aligned}$$

with first-order conditions

$$\frac{\partial \mathscr{L}}{\partial c_t^F} = u_{c^F} - \lambda_{1t} = 0 \tag{1.26.1}$$

$$\frac{\partial \mathscr{L}}{\partial c_t^I} = u_{c^I} - \lambda_{1t} p_t = 0 \tag{1.26.2}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^F} = u_{n^F} + \lambda_{1t} w_t (1-\tau_y) + \lambda_{2t} D_{n^F} h_t = 0 \tag{1.26.3}$$

$$\frac{\partial \mathscr{L}}{\partial n_t^I} = u_{n^I} + \lambda_{1t} p_t f_{n^I}^I + \lambda_{2t} D_{n^I} h_t = 0 \tag{1.26.4}$$

$$\frac{\partial \mathscr{L}}{\partial k_{t+1}} = -\lambda_{1t} + \beta E_t \lambda_{1t+1} \left[r_{t+1}(1-\tau_y) + (1-\delta_k) \right] = 0 \tag{1.26.5}$$

$$\frac{\partial \mathscr{L}}{\partial h_{t+1}} = \lambda_{2t} + \beta E_t \left\{ u_h + \lambda_{1t+1} p_t f_h^I - \lambda_{2t+1} \left[1 - \delta_h - D(n_{t+1}^F, n_{t+1}^I) \right] \right\} = 0 \tag{1.26.6}$$

$$\frac{\partial \mathscr{L}}{\partial m_t^{PT}} = -\lambda_{1t} p_t^{PT} - \lambda_{2t} H_{m^{PT}} = 0 \tag{1.26.7}$$

$$\frac{\partial \mathscr{L}}{\partial m_t^C} = -\lambda_{1t} p_t^C (1-\theta_C) - \lambda_{2t} H_{m^C} = 0 \tag{1.26.8}$$

$$\frac{\partial \mathscr{L}}{\partial m_t^{NC}} = -\lambda_{1t} p_t^{NC} (1-\theta_{NC}) - \lambda_{2t} H_{m^{NC}} = 0 \tag{1.26.9}$$

where λ_1 and λ_2 are the Lagrange multipliers associated to the budget constraint and the health law of motion, respectively.

Combining equations (1.26.1), (1.26.3), and (1.26.7) we obtain:

$$-\frac{u_{n^F}}{u_{c^F}} = w_t(1-\tau_y) - \frac{p_t^{PT} D_{n^F} h_t}{H_{m^{PT}}}, \tag{1.27}$$

and from equations (1.26.2), (1.26.4), and (1.26.7) we have:

$$-\frac{u_{n^I}}{u_{c^I}} = f_{n_t^I} - \frac{p_t^{PT} D_{n^I} h_t}{p_t H_{m^{PT}}}. \tag{1.28}$$

The above equations represent the intra-temporal condition that governs the choice between working hours and leisure in the formal and informal sectors, respectively. These conditions suggest that working hours' opportunity cost is lower in our model compared to the formal-only and no health version of the model. In this case, the marginal rate of substitution between work and consumption is affected by the marginal depreciation of work and the value of the marginal product of health spending.

Similarly, by equations (1.26.1), (1.26.5), and (1.26.7) we can derive:

$$u_{c_t^F} = \beta E_t u_{c_{t+1}^F} [r_{t+1}(1-\tau_y) + 1 - \delta_k], \tag{1.29}$$

and by equations (1.26.1), (1.26.2), (1.26.6), and (1.26.7) we have:

$$u_{c_t^F} = \beta \frac{H_{m_t^{PT}}}{p_t^{PT}} E_t \left\{ u_{h_{t+1}} + u_{c_{t+1}^I} f_{h_{t+1}}^I + \frac{u_{c_{t+1}^F} p_{t+1}^{PT} [1 - \delta_h - D(n_{t+1}^F, n_{t+1}^I)]}{H_{m_{t+1}^{PT}}} \right\}. \tag{1.30}$$

Equation (1.29) is the conventional inter-temporal Euler equation for physical capital, and (1.30) is the Euler equation regarding the accumulation of health stock. The latter implies that the representative household faces a trade-off between consumption and health expenditures. If the household chooses to spend one additional unit on health expenditure (from the private sector in this case), it loses utility by $u_{c_t^F}$, but gains through increasing health stock tomorrow by the amount of $H_{m_t^{PT}}/p_t^{PT}$. Higher health stock tomorrow will bring the household higher utility by $u_{h_{t+1}}$ since health directly enters into the utility function. This effect is called in the literature the consumption motive associated with Grossman (1972). With better health, the effective labor supply increases, which in turn transforms into higher labor income and higher consumption, which yields higher utility. The term $u_{c_{t+1}^I} f^I_{h_{t+1}}$ thus captures the so-called investment motive for health expenditures. Finally, with better health tomorrow, the household also has a better starting point of health stock brought to the future, which saves medical expenditure and can hence be used for higher consumption in the long run. This continuation effect is captured by the last term of (1.30).

Combining equations (1.26.1) and (1.26.1), we obtain the relative price of informal goods as:

$$p_t = \frac{u_{c_t^I}}{u_{c_t^F}}. \tag{1.31}$$

Finally, from equations (1.26.7), (1.26.8), and (1.26.9) we have the conditions that determines the demand of medical services each period:

$$p_t^C = \frac{p_t^{PT} H_{m_t^C}}{(1-\theta_C) H_{m_t^{PT}}}, \tag{1.32}$$

$$p_t^{NC} = \frac{p_t^{PT} H_{m_t^{NC}}}{(1-\theta_{NC}) H_{m_t^{PT}}}. \tag{1.33}$$

1.8 Firm optimization

The formal firm chooses in every period the set of capital and labor that maximizes its profits. The first-order conditions are given by:

$$\frac{\partial \Pi_t^F}{\partial k_t} = \alpha_F z_t^F (k_t)^{\alpha_F - 1} (n_t^F h_t)^{1-\alpha_F} - r_t = 0 \tag{1.34.1}$$

$$\frac{\partial \Pi_t^F}{\partial n_t^F} = (1-\alpha_F) z_t^F (k_t)^{\alpha_F} (n_t^F)^{-\alpha_F} h_t^{1-\alpha_F} - [1 + (1-\eta)\tau_c] w_t = 0. \tag{1.34.2}$$

These equations are the conventional optimality conditions for a firm with distortionary taxation on the labor side.

In the medical sector, the first-order conditions are given by:

$$\frac{\partial \Pi_t^{PT}}{\partial m_t^{PT}} = p_t^{PT} - \psi_{PT} a_t^{PT} (m_t^{PT})^{\psi_{PT}-1} = 0 \tag{1.35.1}$$

$$\frac{\partial \Pi_t^{C}}{\partial m_t^{C}} = p_t^{C} - \psi_{C} a_t^{C} (m_t^{C})^{\psi_{C}-1} = 0 \tag{1.35.2}$$

$$\frac{\partial \Pi_t^{NC}}{\partial m_t^{NC}} = p_t^{NC} - \psi_{NC} a_t^{NC} (m_t^{NC})^{\psi_{NC}-1} = 0\,. \tag{1.35.3}$$

These are the conventional optimality conditions for a firm under perfect competition.

1.9 Equilibrium

Given the initial conditions k_0 and h_0, an equilibrium in this economy is a set of 13 allocations

$$\{y_t^F, y_t^I, i_t, g_t, c_t^F, c_t^I, n_t^F, n_t^I, k_{t+1}, h_{t+1}, m_t^{PT}, m_t^C, m_t^{NC}\}_{t=0}^{\infty}$$

and 6 prices

$$\{w_t, r_t, p_t, p_t^{PT}, p_t^C, p_t^{NC}\}_{t=0}^{\infty}$$

such that, given the law of motion of shocks, satisfy the following 19 conditions:

- the household first-order conditions (1.27), (1.28), (1.29), (1.30), (1.31), (1.32), and (1.33),
- the formal firm first-order conditions (1.34.1) and (1.34.2),
- the medical providers first-order conditions (1.35.1), (1.35.2), and (1.35.3),
- the government budget constraint (1.11),
- market clearing conditions (1.12) and (1.13),
- the production functions in formal and informal sectors (1.9) and (1.3),
- the laws of motion for capital and health stocks (1.2) and (1.1).

Chapter 2

Log-linearization and Parameterization

This chapter presents the log-linearized version of the system of equations that characterize the model's equilibrium. Afterward, we present the discussion about the choice of each of the required parameters to carry out the computational exercises of the following chapter.

2.1 Log-linearization

In what follows, variables whose empirical counterparts are expressed in log deviations are defined by:

$$\hat{s} \equiv \log(s_t) - \log(s) \approx \frac{s_t - s}{s} \tag{2.1}$$

where each variable with a hat represents the approximate percentage deviation with respect to its steady-state (ss) level denoted without subscript. Variables whose empirical counterparts are expressed in levels are defined as:

$$\hat{v} \equiv v_t - v \tag{2.2}$$

where a hat variable denotes the deviation from its steady-state value, as is the case of real interest rate in the present model.

As discussed in Section 1.9 of Chapter 1, the equilibrium of the model can be characterized by a set of 19 sequences

$$\{y_t^F, y_t^I, i_t, g_t, c_t^F, c_t^I, n_t^F, n_t^I, k_{t+1}, h_{t+1}, m_t^{PT}, m_t^C, m_t^{NC}, w_t, r_t, p_t, p_t^{PT}, p_t^C, p_t^{NC}\}_{t=0}^{\infty}$$

satisfying the following 19 equations:

$$p_t = \frac{1-\zeta}{\zeta}\left(\frac{c_t^I}{c_t^F}\right)^{\mu-1} \tag{2.3.1}$$

$$\frac{\zeta(c_t^F)^{\mu-1}w_t(1-\tau_y)}{(c_t^A)^{\mu}} = \gamma_n(n_t^F+n_t^I)^{\chi} + \frac{\zeta(c_t^F)^{\mu-1}p_t^{PT}}{(c_t^A)^{\mu}z_t^m\xi_{PT}}\omega(n_t^F)^{\omega-1}(n_t^I)^{1-\omega}h_t \tag{2.3.2}$$

$$\frac{(1-\zeta)(c_t^I)^{\mu-1}\alpha_I z_t^I(n_t^I)^{\alpha_I-1}h_t^{\alpha_I}}{(c_t^A)^{\mu}} = \gamma_n(n_t^F+n_t^I)^{\chi} + \frac{\zeta(c_t^F)^{\mu-1}p_t^{PT}}{(c_t^A)^{\mu}z_t^m\xi_{PT}}(1-\omega)(n_t^F)^{\omega}(n_t^I)^{-\omega}h_t \tag{2.3.3}$$

$$\frac{\zeta(c_t^F)^{\mu-1}}{(c_t^A)^{\mu}} = \beta E_t\frac{\zeta(c_{t+1}^F)^{\mu-1}\left[r_{t+1}(1-\tau_y)+(1-\delta_k)\right]}{(c_{t+1}^A)^{\mu}} \tag{2.3.4}$$

$$\begin{aligned}\frac{\zeta(c_t^F)^{\mu-1}p_t^{PT}}{(c_t^A)^{\mu}z_t^m\xi_{PT}} &= \beta E_t\left\{\frac{\zeta(c_{t+1}^F)^{\mu-1}p_{t+1}^{PT}}{(c_{t+1}^A)^{\mu}z_{t+1}^m\xi_{PT}}\left[1-\delta_h-D(n_{t+1}^F,n_{t+1}^I)\right]\right.\\ &\left.+\frac{(1-\zeta)(c_{t+1}^I)^{\mu-1}\alpha_I z_{t+1}^I(n_{t+1}^I)^{\alpha_I}h_{t+1}^{\alpha_I-1}}{(c_{t+1}^A)^{\mu}}+\frac{1}{h_{t+1}}\right\}\end{aligned} \tag{2.3.5}$$

$$p_t^C = \frac{\xi_C p_t^{PT}}{(1-\theta_C)\xi_{PT}} \tag{2.3.6}$$

$$p_t^{NC} = \frac{\xi_{NC} p_t^{PT}}{(1-\theta_{NC})\xi_{PT}} \tag{2.3.7}$$

$$r_t = \alpha_F z_t^F(k_t)^{\alpha_F-1}(n_t^F h_t)^{1-\alpha_F} \tag{2.3.8}$$

$$[1+(1-\eta)\tau_c]w_t = (1-\alpha_F)z_t^F(k_t)^{\alpha_F}(n_t^F)^{-\alpha_F}h_t^{1-\alpha_F} \tag{2.3.9}$$

$$p_t^{PT} = \psi_{PT}a_t^{PT}(m_t^{PT})^{\psi_{PT}-1} \tag{2.3.10}$$

$$p_t^C = \psi_C a_t^C(m_t^C)^{\psi_C-1} \tag{2.3.11}$$

$$p_t^{NC} = \psi_{NC}a_t^{NC}(m_t^{NC})^{\psi_{NC}-1} \tag{2.3.12}$$

$$g_t = (1-\eta)\tau_c w_t n_t^F + \tau_y(w_t n_t^F + r_t k_t) - \theta_C p_t^C m_t^C - \theta_{NC}p_t^{NC}m_t^{NC} \tag{2.3.13}$$

$$y_t^F = c_t^F + i_t + g_t \tag{2.3.14}$$

$$y_t^I = c_t^I \tag{2.3.15}$$

$$y_t^F = z_t^F(k_t)^{\alpha_F}(n_t^F h_t)^{1-\alpha_F} \tag{2.3.16}$$

$$y_t^I = z_t^I(n_t^I h_t)^{\alpha_I} \tag{2.3.17}$$

$$k_{t+1} = i_t + (1-\delta_k)k_t \tag{2.3.18}$$

$$h_{t+1} = z_t^m\left(\xi_{PT}m_t^{PT}+\xi_C m_t^C+\xi_{NC}m_t^{NC}\right) + \left[1-\delta_h-(n_t^F)^{\omega}(n_t^I)^{1-\omega}\right]h_t\,. \tag{2.3.19}$$

Equation (2.3.1) determines the relative price of informal goods, equations (2.3.2) and (2.3.3) are the labor supply conditions of the formal and informal sector, respectively. Equation (2.3.4) is the Euler equation for physical capital and (2.3.5) is the Euler equation regarding the accumulation of health stock. Equations (2.3.6) and (2.3.7) follow from household's first-order conditions for public medical goods. Equations (2.3.8) and (2.3.9) are the first-order conditions of formal firms. Equations (2.3.10)–(2.3.12) are the first-order conditions for each medical firm. Equation (2.3.13) is the government budget constraint. Equation (2.3.14) and (2.3.15) are the market clearing conditions and equations (2.3.16) and (2.3.17) are the production functions of each sector. The last two equations, (2.3.18) and (2.3.19), are the laws of motion for physical capital and health capital.

The corresponding log-linearized equations are given by:

$$\hat{p}_t = (1-\mu)(\hat{c}_t^F - \hat{c}_t^I) \tag{2.4.1}$$

$$\begin{aligned}
Q_1\hat{c}_t^F - Q_2\hat{c}_t^I + \hat{w}_t = \frac{1}{A_1}\Bigg\{ & \frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}} \frac{p^{PT}}{z^m\xi_{PT}}\omega(n^F)^{\omega-1}(n^I)^{1-\omega}\frac{h}{y^F}(\hat{h}_t + \hat{p}_t^{PT} - \hat{z}_t^m) \\
& + \left[\chi\gamma_n(n^F+n^I)^{\chi-1}n^F + \frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}} \frac{p^{PT}}{z^m\xi_{PT}}(\omega-1)\omega(n^F)^{\omega-1}(n^I)^{1-\omega}\frac{h}{y^F}\right]\hat{n}_t^F \\
& + \left[\chi\gamma_n(n^F+n^I)^{\chi-1}n^I + \frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}} \frac{p^{PT}}{z^m\xi_{PT}}(1-\omega)\omega(n^F)^{\omega-1}(n^I)^{1-\omega}\frac{h}{y^F}\right]\hat{n}_t^I \\
& + \frac{(\mu-1)\zeta\left(\frac{c^F}{y^F}\right)^{\mu-2}\frac{c^A}{y^F} - \mu\zeta^2\left(\frac{c^F}{y^F}\right)^{2\mu-2}}{\left(\frac{c^A}{y^F}\right)^2} \frac{p^{PT}}{z^m\xi_{PT}}\omega(n^F)^{\omega-1}(n^I)^{1-\omega}\frac{h}{y^F}\frac{c^F}{y^F}\hat{c}_t^F \\
& + \frac{\mu\zeta(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\left(\frac{c^A}{y^F}\right)^2} \frac{p^{PT}}{z^m\xi_{PT}}\omega(n^F)^{\omega-1}(n^I)^{1-\omega}\frac{h}{y^F}\frac{c^I}{y^F}\hat{c}_t^I \Bigg\}
\end{aligned} \tag{2.4.2}$$

$$\begin{aligned}
& Q_4\hat{c}_t^I - Q_3\hat{c}_t^F + \hat{z}_t^I + (\alpha_I - 1)\hat{n}_t^I + \alpha_I\hat{h}_t = \\
& \frac{1}{A_2}\Bigg\{\left[\chi\gamma_n(n^F+n^I)^{\chi-1}n^F + \frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}} \frac{p^{PT}}{z^m\xi_{PT}}\omega(1-\omega)(n^F)^{\omega}(n^I)^{-\omega}\frac{h}{y^F}\right]\hat{n}_t^F \\
& + \left[\chi\gamma_n(n^F+n^I)^{\chi-1}n^I - \frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}} \frac{p^{PT}}{z^m\xi_{PT}}\omega(1-\omega)(n^F)^{\omega}(n^I)^{-\omega}\frac{h}{y^F}\right]\hat{n}_t^I \\
& + \frac{(\mu-1)\zeta\left(\frac{c^F}{y^F}\right)^{\mu-2}\frac{c^A}{y^F} - \mu\zeta^2\left(\frac{c^F}{y^F}\right)^{2\mu-2}}{\left(\frac{c^A}{y^F}\right)^2} \frac{p^{PT}}{z^m\xi_{PT}}(1-\omega)(n^F)^{\omega}(n^I)^{-\omega}\frac{h}{y^F}\frac{c^F}{y^F}\hat{c}_t^F \\
& + \frac{\mu\zeta(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\left(\frac{c^A}{y^F}\right)^2} \frac{p^{PT}}{z^m\xi_{PT}}(1-\omega)(n^F)^{\omega}(n^I)^{-\omega}\frac{h}{y^F}\frac{c^I}{y^F}\hat{c}_t^I
\end{aligned}$$

$$+\frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}}\frac{p^{PT}}{z^m\xi_{PT}}(1-\omega)(n^F)^{\omega}(n^I)^{-\omega}\frac{h}{y^F}(\hat{h}_t+\hat{p}_t^{PT}-\hat{z}_t^m)\Bigg\} \tag{2.4.3}$$

$$Q_2E_t\left[\hat{c}^I_{t+1}-\hat{c}^I_t\right]-Q_1E_t\left[\hat{c}^F_{t+1}-\hat{c}^F_t\right]=\frac{1-\tau_y}{r(1-\tau_y)+(1-\delta_k)}E_t\hat{r}_{t+1} \tag{2.4.4}$$

$$Q_1\hat{c}^F_t-Q_2\hat{c}^I_t+\hat{p}^{PT}_t-\hat{z}^m_t=$$

$$\frac{\beta}{A_3}\frac{y^F}{hy^F}E_t\Bigg\{\frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}}\frac{p^{PT}}{z^m\xi_{PT}}\frac{h}{y^F}[1-\delta_h-(n^F)^{\omega}(n^I)^{1-\omega}](\hat{p}^{PT}_{t+1}-\hat{z}^m_{t+1})$$

$$+\Bigg[\frac{\mu\zeta(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\left(\frac{c^A}{y^F}\right)^2}\alpha_I\frac{c^F}{y^F}\frac{c^I}{y^F}$$

$$+\frac{(\mu-1)\zeta\left(\frac{c^F}{y^F}\right)^{\mu-2}\frac{c^A}{y^F}-\mu\zeta^2\left(\frac{c^F}{y^F}\right)^{2\mu-2}}{\left(\frac{c^A}{y^F}\right)^2}\frac{p^{PT}}{z^m\xi_{PT}}\frac{c^F}{y^F}\frac{h}{y^F}[1-\delta_h-(n^F)^{\omega}(n^I)^{1-\omega}]\Bigg]\hat{c}^F_{t+1}$$

$$+\Bigg[\frac{\mu\zeta(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\left(\frac{c^A}{y^F}\right)^2}\alpha_I\frac{c^I}{y^F}\frac{c^I}{y^F}$$

$$+\frac{\mu\zeta(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\left(\frac{c^A}{y^F}\right)^2}\frac{p^{PT}}{z^m\xi_{PT}}\frac{c^I}{y^F}\frac{h}{y^F}[1-\delta_h-(n^F)^{\omega}(n^I)^{1-\omega}]\Bigg]\hat{c}^I_{t+1}$$

$$-\frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}}\frac{p^{PT}}{z^m\xi_{PT}}\frac{h}{y^F}\omega(n^F)^{\omega}(n^I)^{1-\omega}\hat{n}^F_{t+1}$$

$$+\Bigg[\frac{(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}}\alpha_I^2\frac{c^I}{y^F}-\frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}}\frac{p^{PT}}{z^m\xi_{PT}}\frac{h}{y^F}(1-\omega)(n^F)^{\omega}(n^I)^{1-\omega}\Bigg]\hat{n}^I_{t+1}$$

$$-\Bigg[1-\frac{(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}}(\alpha_I-1)\alpha_I\frac{c^I}{y^F}\Bigg]\hat{h}_{t+1}-\frac{(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}}{\frac{c^A}{y^F}}\alpha_I\frac{c^I}{y^F}\hat{z}^I_{t+1}\Bigg\} \tag{2.4.5}$$

$$\hat{p}^C_t=\hat{p}^{PT}_t \tag{2.4.6}$$

$$\hat{p}^{NC}_t=\hat{p}^{PT}_t \tag{2.4.7}$$

$$\frac{\hat{r}_t}{r}=\hat{z}^F_t+(1-\alpha_F)(\hat{n}^F_t+\hat{h}_t-\hat{k}_t) \tag{2.4.8}$$

$$\hat{w}_t=\hat{z}^F_t+\alpha_F(\hat{k}_t-\hat{n}^F_t)+(1-\alpha_F)\hat{h}_t \tag{2.4.9}$$

$$\hat{p}^{PT}_t=\hat{a}^{PT}_t-(1-\psi_{PT})\hat{m}^{PT}_t \tag{2.4.10}$$

$$\hat{p}^C_t=\hat{a}^C_t-(1-\psi_C)\hat{m}^C_t \tag{2.4.11}$$

$$\hat{p}^{NC}_t=\hat{a}^{NC}_t-(1-\psi_{NC})\hat{m}^{NC}_t \tag{2.4.12}$$

$$\frac{g}{y^F}\hat{g}_t = \frac{(1-\alpha_F)[(1-\eta)\tau_c+\tau_y]}{1+(1-\eta)\tau_c}(\hat{n}_t^F+\hat{w}_t)+\tau_y r\frac{k}{y^F}(\hat{r}_t+\hat{k}_t)$$
$$-\theta_C p^C \frac{m^C}{y^F}(\hat{p}_t^C+\hat{m}_t^C)-\theta_{NC}p^{NC}\frac{m^{NC}}{y^F}(\hat{p}_t^{NC}+\hat{m}_t^{NC}) \tag{2.4.13}$$
$$\hat{y}_t^F = \frac{c^F}{y_t^F}\hat{c}_t^F+\frac{i}{y_t^F}\hat{i}_t+\frac{g}{y_t^F}\hat{g}_t \tag{2.4.14}$$
$$\hat{y}_t^I = \hat{c}_t^I \tag{2.4.15}$$
$$\hat{y}_t^F = \hat{z}_t^F+\alpha_F\hat{k}_t+(1-\alpha_F)(\hat{n}_t^F+\hat{h}_t) \tag{2.4.16}$$
$$\hat{y}_t^I = \hat{z}_t^I+\alpha_I(\hat{n}_t^I+\hat{h}_t) \tag{2.4.17}$$
$$\hat{k}_{t+1}-\hat{k}_t = \delta_k[\hat{i}_t-\hat{k}_t] \tag{2.4.18}$$
$$\frac{h}{y^F}\hat{h}_{t+1} = z^m\left(\xi_{PT}\frac{m^{PT}}{y^F}+\xi_C\frac{m^C}{y^F}+\xi_{NC}\frac{m^{NC}}{y^F}\right)\hat{z}_t^m$$
$$+z^m\left(\xi_{PT}\frac{m^{PT}}{y^F}\hat{m}_t^{PT}+\xi_C\frac{m^C}{y^F}\hat{m}_t^C+\xi_{NC}\frac{m^{NC}}{y^F}\hat{m}_t^{NC}\right)-\omega(n^F)^{\omega}(n^I)^{1-\omega}\frac{h}{y^F}\hat{n}_t^F$$
$$-(1-\omega)(n^F)^{\omega}(n^I)^{1-\omega}\frac{h}{y^F}\hat{n}_t^I+\left[1-\delta_h-(n^F)^{\omega}(n^I)^{1-\omega}\right]\frac{h}{y^F}\hat{h}_t \tag{2.4.19}$$

where $\frac{c^A}{y^F} = \left[\zeta\left(\frac{c^F}{y^F}\right)^{\mu}+(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu}\right]$, $Q_1 = \frac{(\mu-1)\frac{c^A}{y^F}-\mu\zeta\left(\frac{c^F}{y^F}\right)^{\mu}}{\frac{c^A}{y^F}}$, $Q_2 = \frac{\mu(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu}}{\frac{c^A}{y^F}}$, $Q_3 = \frac{(\mu-1)\frac{c^A}{y^F}-\mu(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu}}{\frac{c^A}{y^F}}$, $Q_4 = \frac{\mu\zeta\left(\frac{c^F}{y^F}\right)^{\mu}}{\frac{c^A}{y^F}}$, $A_1 = \frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}(1-\alpha_F)(1-\tau_y)}{\frac{c^A}{y^F}[1+(1-\eta)\tau_c]n^F}$, $A_2 = \frac{(1-\zeta)\left(\frac{c^I}{y^F}\right)^{\mu-1}\alpha_I\frac{c^I}{y^F n^I}}{\frac{c^A}{y^F}}$, and $A_3 = \frac{\zeta\left(\frac{c^F}{y^F}\right)^{\mu-1}p^{PT}}{\frac{c^A}{y^F}y^F z^m\xi_{PT}}$. Note that in A_1 and (2.4.13) we have used that $w = \frac{(1-\alpha_F)y^F}{[1+(1-\eta)\tau_c]n^F}$ which follows from equation (2.3.9) in the steady-state.

2.2 Parameterization

The model requires setting values for 21 parameters, which are summarized in Table 2.1. The unit of time is assumed to be a quarter. The parameters of the discount factor β and the depreciation of physical capital δ_k are standard in the literature and do not need major explanation. Similarly, the χ parameter which is related to the Frisch labor supply elasticity is set at a moderate value consistent with the emerging business cycle literature such as Aguiar and Gopinath (2004).

The absence of data on informal consumption makes it difficult to establish the parameters of the consumption aggregator. Restrepo-Echavarria (2014) assumes that formal and informal consumption goods are perfect substitutes ($\mu = 1$), whereas Fernández and Meza (2015) choose $\mu = 0.875$ which implies a elasticity of substitution between formal and informal goods of $1/(1-\mu) = 8$. In their baseline calibration consumption of formal goods make up 68% of total consumption. We follow Fernández and Meza (2015) and set $\mu = 0.875$ and $\zeta = 0.68$

The parameter γ_n, which gauges the importance of leisure relative to consumption/health in preferences, is taken from He et al. (2016), which is consistent with households allocating one-third of their time to work.

As in Restrepo-Echavarria (2014), we assume that the informal sector only uses labor for production. She sets the parameter determining the degree of decreasing returns $\alpha_I = 0.3$. We set the same value. The formal capital share in the production function α_F is taken from Fernández and Meza (2015), who finds that the share of capital in Mexico has a value similar to that in the United States. This parameter selection is consistent with the inclusion of health stock in the production function, as shown by Kelly (2017) and He et al. (2016), who calibrate their model for the USA.

The parameters for the income tax τ_y and the tax on the wage bill τ_c are also taken form Fernández and Meza (2015). Those parameters match the average annual value for these variables from 2003 to 2008. In particular, they calculate τ_y as the ratio of aggregate individual income tax revenue to the sum of wages, salaries, and household income from capital, and τ_c as the ratio from tax collection regarding the payments that firms make as social contributions to the tax base. The government contribution to social insurance η is taken from Antón et al. (2012). The value chosen corresponds to the Mexican government subsidies allocated by law to health and life and disability insurance and retirement pensions for 2008.

The parameter θ_{NC} matches the annual average for the period 1999 to 2017 of the federal contributions to health institutions that serve the population without social security, based on the data available on the Subsystem of Health Accounts at the Federal and State Level (SICUENTAS, for its acronym in Spanish).

For the θ_C parameter, we consider the income share of IMSS, the main provider of medical services for the Mexican population with social security, which comes from worker-employer contributions plus contributions from the federal government (discounting the part that it grants specifically for people without security social, approximately 5% of the total). We take the annual average of this calculation from 2018 to 2020, based on information from SICUENTAS and the IMSS institutional reports.[1]

Various sources are used to establish the parameters of the curvature of cost functions in the medical industry $\psi_x, x \in \{PT, C, NC\}$. Arredondo, Damían, and De Icaza (1995) elaborates a cost analysis of health services in "tracer events" for different public and private institutions in Mexico.[2] For this, they first establish the production functions for each event and each institution and then make a consensus among practitioners to adjust each institution's function.

[1] The discrepancy between the parameterization periods for θ_C and θ_{NC} is because the data with which the value of θ_C was calculated is not publicly available for the same period in which θ_{NC} was calculated (1999 - 2017).

[2] A tracer event means a particular disease and all the treatment that it requires. The tracer conditions of that study were: hypertension, diabetes, diarrheas, pneumonia, appendicectomy, labor and delivery cares, routine ambulatory medical care, and vaccines.

They find that the differences in costs for each tracer event are significant between institutions. In particular, they identify that the lowest costs are in the public sector, especially in the main NCSI medical provider, and the highest costs correspond to the private sector.[3] On the other hand, Kelly (2017) sets the value $\psi_{PT} = 1.5$ to pin down the relative price of medical consumption to non-medical consumption for the US from 1996 to 2013. So we set that value to the private medical cost function, and based on the findings of Arredondo et al. (1995), we set an arbitrary lower parameter for CSI medical provider and even a lower value for the NCSI medical provider.

Dalgaard and Strulik (2014) define aging as the development of an increasing number of "deficits" and they estimate that the aggregate average accumulation of deficits is 3–4% per year. Consequently, we set the exogenous health depreciation rate δ_h to 0.01.

The literature on health differences between formal and informal workers is very narrow. However, some studies show that low-income people tend to forego some medical services (such as dental care) because they do not consider them essential (WHO, 2019). For that reason, it is expected that informal workers have worse health than formal workers. So we arbitrarily set the parameter for the curvature of the endogenous health depreciation ω at a value of 0.25.

One problem in choosing the production function parameters is that no previous study has used the same inputs as those proposed here to analyze the effects on health. However, given that the NCSI covers a limited number of diseases compared with the CSI is naturally expected that medical services from the CSI provide better quality health than those of NCSI. Moreover, to be consistent with the higher cost of private medical goods, we assume that these services provide a greater contribution to health than public medical services. In particular, we choose $\xi_{PT} = 0.45$, $\xi_C = 0.35$, and $\xi_{NC} = 0.20$.

The parameters for the formal and informal productivity shocks are taken from Fernández and Meza (2015), who set the persistence parameter $\rho_F = 0.72$ and the pass-through parameter of shocks from the formal to informal sectors $\kappa = 0.64$. For each productivity shock in the medical sector, we set the persistence parameter $\rho_x = 0.9$.

In our log-linearized system (2.4) we have expressed most quantities as a proportion of formal production to set them with available empirical evidence. The components of aggregate spending are calculated using the observed averages from 1993 to 2020 for the Mexican economy with data from INEGI. The private consumption-output ratio is 0.51, the private investment-output ratio is 0.12, and government consumption-output ratio is 0.09.

Similarly, the different spending values on medical services are fixed by the average observed from 1993 to 2017 with data from SICUENTAS. The ratios of private medical spending, public spending on contributory social security, and public spending on non-contributory social

[3] More precisely, Arredondo et al. (1995) find the lowest costs at hospitals form Secretaria de Salud. However, in Mexico, the NCSI was created in 2003, and the main medical provider was the Secretaria de Salud. That is why we made the equivalency between those institutions to set the cost function parameters.

security are 0.03, 0.0101, and 0.0170, respectively.

We set the informal consumption-formal output ratio to 0.36 based on the empirical evidence outlined in Restrepo-Echavarria (2014). Remember that informal consumption equals informal output in our model. Following Fernández and Meza (2015), we choose the steady-state values of labor hours n^F and n^I such that $n^I/(n^F+n^I)=0.35$ and $n^F+n^I=1/3$. The former to match the observed average across different measures of informality in Mexico, and the latter to match conventional time work in business cycles analysis.

The physical capital law of motion (2.3.18) implies that investment in the steady state is equal to $\delta_k k$, so we can obtain the capital-output ratio as $\frac{k}{y^F}=\frac{i}{y^F\delta_k}$. From equation (2.3.4), the real interest rate in the steady-state is $r=(1/\beta+\delta_k-1)/(1-\tau_y)$, and using equation (2.3.8) we can determine the stock of health capital-output ratio in the steady-state as $\frac{h}{y^F}=\left(\frac{r}{\alpha_F z^F}\right)^{\frac{1}{1-\alpha_F}}\frac{k}{y^F n^F}$.

Kelly (2017) documents for the U.S. that the average relative price of medical goods to non-medical goods from 1996 to 2013 is 1.5. For simplicity, we assign that value to the relative price of private medical goods in the steady-state, and based on the evidence shown by Arredondo et al. (1995), we set an arbitrary lower value for CSI medical services and even a lower value for the NCSI medical services.

Parameter	Value	Description	Source
α_I	0.3	Degree of decreasing returns of labor in the informal production	Restrepo-Echavarria (2014)
α_F	0.35	Share of capital/labor in the formal production function	Fernández and Meza (2015)
β	0.98	Discount factor	Aguiar and Gopinath (2007)
γ_n	2.06	Preference parameter for leisure time	He et al. (2016)
χ	1.6	Wage elasticity of labor	Aguiar and Gopinath (2004)
δ_k	0.05	Depreciation of physical capital	Fernández and Meza (2015)
δ_h	0.01	Depreciation of health capital	Dalgaard and Strulik (2014)
ζ	0.6831	Share of formal goods in aggregate consumption	Fernández and Meza (2015)
μ	0.875	Sets elasticity of substitution between goods	Fernández and Meza (2015)
η	0.16	Government contribution to financing the CSI	Antón et al. (2012)
θ_C	0.91	Share of the medical CSI spending financed by government	Observed average
θ_{NC}	0.85	Share of the medical NCSI spending financed by government	Observed average
ξ_{PT}	0.45	Contribution of private medical goods to health production	Arbitrary
ξ_C	0.35	Contribution of CSI medical goods to health production	Arbitrary
ξ_{NC}	0.20	Contribution of NCSI medical goods to health production	Arbitrary
τ_y	0.0722	Income tax	Fernández and Meza (2015)
τ_c	0.1142	Tax on the wage bill	Fernández and Meza (2015)
ψ_{PT}	1.5	Curvature of the private medical cost function	Kelly (2017)
ψ_C	1.3	Curvature of the CSI medical cost function	Arredondo et al. (1995); Kelly (2017)
ψ_{NC}	1.1	Curvature of the NCSI medical cost function	Arredondo et al. (1995); Kelly (2017)
ω	0.25	Curvature of the endogenous health depreciation	Arbitrary

Parameter	Value	Description	Source
ρ_F	0.72	Persistence parameter of formal productivity shock	Fernández and Meza (2015)
κ	0.64	Pass-through parameter of shocks from the formal to informal sector	Fernández and Meza (2015)
ρ_{PT}	0.9	Persistence parameter of private medical provider cost shock	Arbitrary
ρ_C	0.9	Persistence parameter of CSI medical provider cost shock	Arbitrary
ρ_{NC}	0.9	Persistence parameter of NCSI medical provider cost shock	Arbitrary
c^F/y^F	0.51	Private formal consumption-output ratio in the steady-state	Own calculations
c^I/y^F	0.36	Informal consumption-output ratio in the steady-state	Restrepo-Echavarria (2014)
i/y^F	0.12	Private investment-output ratio in the steady-state	Own calculations
g/y^F	0.09	Government consumption-output ratio in the steady-state	Own calculations
m^{PT}/y^F	0.03	Private medical spending-output ratio in the steady-state	Own calculations
m^C/y^F	0.010	CSI medical spending-output ratio in the steady-state	Own calculations
m^{NC}/y^F	0.017	NCSI medical spending-output ratio in the steady-state	Own calculations
n^F	0.2162	Formal labor in the steady-state	Fernández and Meza (2015)
n^I	0.1171	Informal labor in the steady-state	Fernández and Meza (2015)

Table 2.1: Baseline parameterization

Chapter 3

Model Dynamics

In this chapter, we present our main results. First, we analyze the transition dynamics of a 1% increase to each of the following: formal goods productivity, health investment productivity, private medical provider cost, and the CSI and NCSI medical providers costs. Second, we discuss our results in light of the existing literature. A sensitivity analysis to show the robustness of the results to the parameter selection concludes the chapter.

3.1 Transitional dynamics

3.1.1 Formal productivity shock

Figure 3.1 presents the impulse responses under a positive 1% shock to formal productivity. Immediately after the shock both formal and informal output follow opposite trajectories. Formal output falls almost 0.15% on impact, whereas informal output grows initially 0.4%, and then gradually returns to the steady state value around 25 quarters after the shock.

Formal consumption also decreases in relation to its steady-state value by almost 1.2%. Subsequently, the deviation continues to increase until it reaches a minimum (around period five) and gradually decreases thereafter. Remember that informal consumption is equal to informal output, so the consumption in this sector increases. Nevertheless, aggregate consumption falls on impact and follows a similar trajectory as formal consumption.

Investment instantaneously decreases by 3% due to the productivity shock, and still decreasing by a few periods. Afterward, investment rapidly grows even above its steady-state value. Initially, the decrease in investment causes a decrease in physical capital stock (net investment is negative). However, as investment increases, the capital stock reaches a minimum, after which it begins to increase.

Formal labor reduces between 3 and 4 percentage points in the first quarters after the shock, and then gradually increases. The informal labor follows a similar pattern as the formal work, but with fewer magnitude.

We can see that all health expenditures also fall initially as a consequence of the shock. The private medical consumption and the CSI medical consumption decrease between 1 and 3 percentage points in first the periods after the shock, and then it begin growing for a long time. The same is true for the NCSI medical consumption, but in greater magnitude, since the initial decrease is near 5%. However, health capital accumulation grows on impact due to the decline in working hours in formal and informal sectors.

Regarding production factor prices, there is an increase in wages as a result of the gains in productivity. The real interest rate initially undergoes a slight negative change, but later increases above its steady-state value due to the process of capital accumulation.

Government spending declines immediately after the shock due to the decline in their earnings by both taxes (the shock has decline working hours, real interest rate, and physical capital accumulation, some of the main components of government taxation). However, rapidly the government consumption becomes positive as tax base increase.

3.1.2 Health investment productivity shock

Figure 3.2 presents the impulse responses under a positive 1% shock to health investment productivity. As we can see, the results are very different from the formal productivity shock. Both the formal and informal output rise on impact, but the former declines rapidly below its steady-state value reaching a minimum near period 18, and the latter still growing until 18 periods after the shock. Formal consumption follows a similar trajectory as formal output, it decreases in relation to its steady-state value by 0.1% on impact and still decreasing after that. Aggregate consumption falls on impact due to the decline in formal consumption and the little increase of informal one. It takes near 35 periods to return to its steady-state value.

Investment instantaneously increases by more than 2% due to the productivity shock, but afterward, investment rapidly declines even below its steady-state value. Physical capital stock shows a bell-shaped impulse-response function in the first 15 periods after the shock. Initially, the increase in investment causes an increase in capital stock (net investment is positive). However, as investment decreases, the capital stock reaches a maximum, after which it begins to decrease.

Formal labor reduces more than 0.1% percent in the first 15 quarters after the shock (even when the real wage has risen), and then gradually increases. Informal labor slightly increases after the shock, but then it falls and follows a similar pattern as the formal work.

As expected, health expenditures rise considerably after the shock, which implies greater health capital accumulation. The private medical consumption and the CSI medical consumption increase between 2% and 3% in the first periods after the shock, and then they gradually decline reaching a minimum after 20 quarters. The same is true for the NCSI medical consumption, but in greater magnitude, since the initial increase is almost 10%. Government non-medical consumption falls immediately after the shock as demand for public medical services

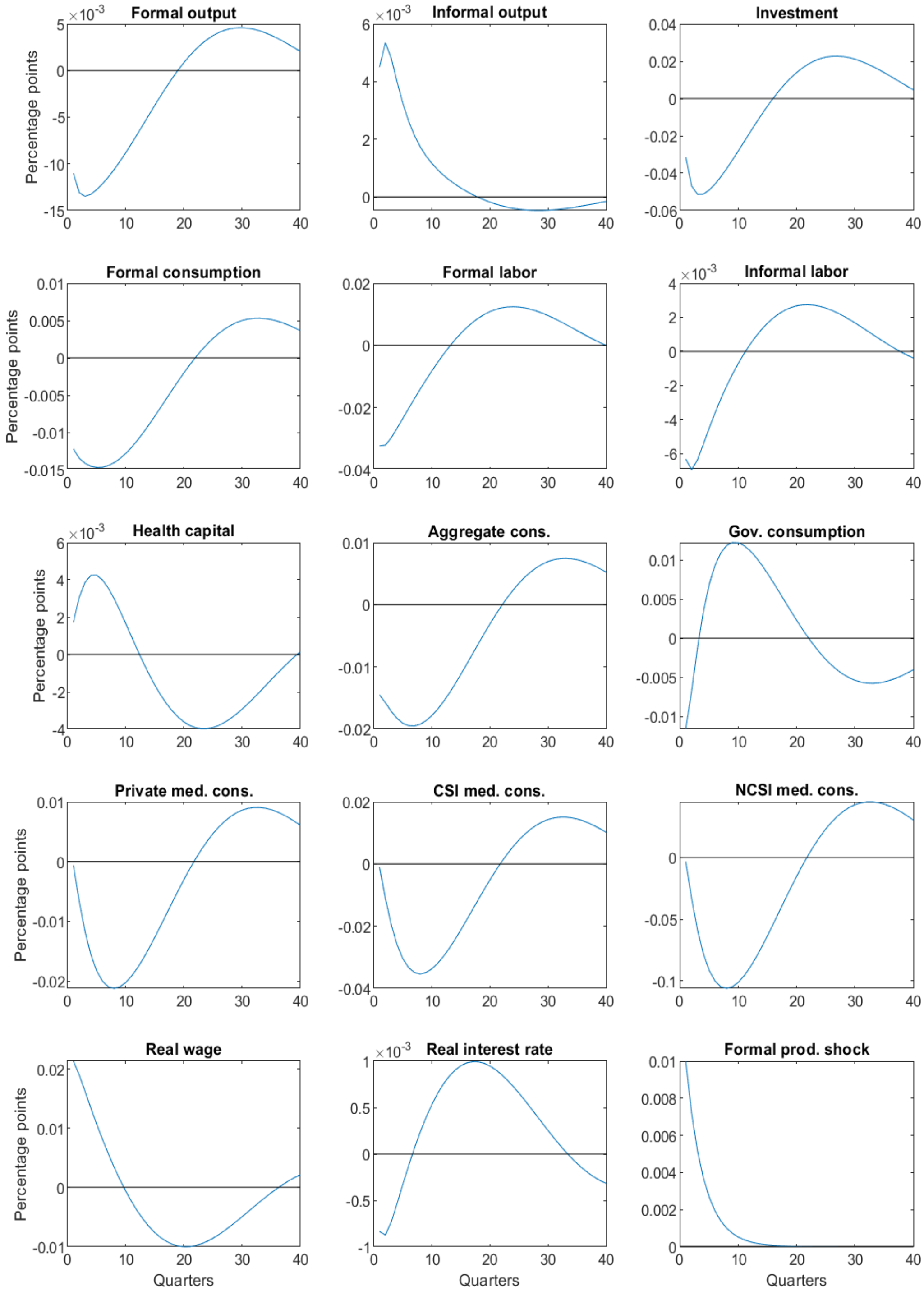

Figure 3.1: Impulse responses under a positive 1% shock to formal technology.

increases.

Regarding production factor prices, there is an increase in wages as a result of the gains in productivity. The real interest rate initially undergoes a slight positive change, given the increase in the marginal productivity of capital, but later decreases below its steady-state value due to the process of capital accumulation.

One way to interpret these results is the following. When the health investment positive productivity shock arises, formal and informal output increases as medical inputs become more productive, and health improves. This effect is reinforced by the greater investment in health capital since people choose to substitute labor for medical goods to exploit the gains of the productivity shock. Consequently, there is a reallocation of resources to the medical sector since households reduce both formal and informal labor time in order to increase its health capital. In that way, our model does a reasonably good job of replicating the increase in medical expenditure similar to the findings of Kelly (2017) for the US.

3.1.3 Cost shocks in the medical sector

Figures 3.3, 3.4, and 3.5 present the impulse responses under a positive 1% shock to the cost function of the private medical provider, CSI medical provider, and the NCSI medical provider, respectively. Since the three shocks are symmetric, the results in those graphs are also symmetric, so we focus only on the private shock and just mention the differences with other two shocks.

In the case of private medical provider cost shocks, both formal and informal output follow opposite trajectories. Formal output slightly decreases in first periods, but then it rapidly rises above its steady-state value up to a maximum is reached near 15 quarters after the shock. On the other hand, informal output decreases modestly by 0.0015% on impact, and gradually rises until reach its steady-state value 38 periods ahead.

Formal consumption instantaneously increases in relation to its steady-state value, but by a small proportion (almost 0.01%). Subsequently, the deviation continues to increase until it reaches a maximum (around period 20) and gradually decreases thereafter. Despite the decrease in informal consumption, aggregate consumption rises on impact due to the increase in formal consumption.

Investment instantaneously decreases by 0.4% due to the private medical provider cost shock, but afterward, investment rapidly increases even above its steady-state value. Initially, the decline in investment causes a decline in capital stock (net investment is negative). Subsequently, as investment increases, the capital stock reaches a minimum after which it begins to increase.

Both formal and informal labor reduces slightly on impact, and gradually begin rise reaching a level above their steady-state value. Formal labor increases in greater magnitude than informal labor, so there is a reallocation of labor time to this sector.

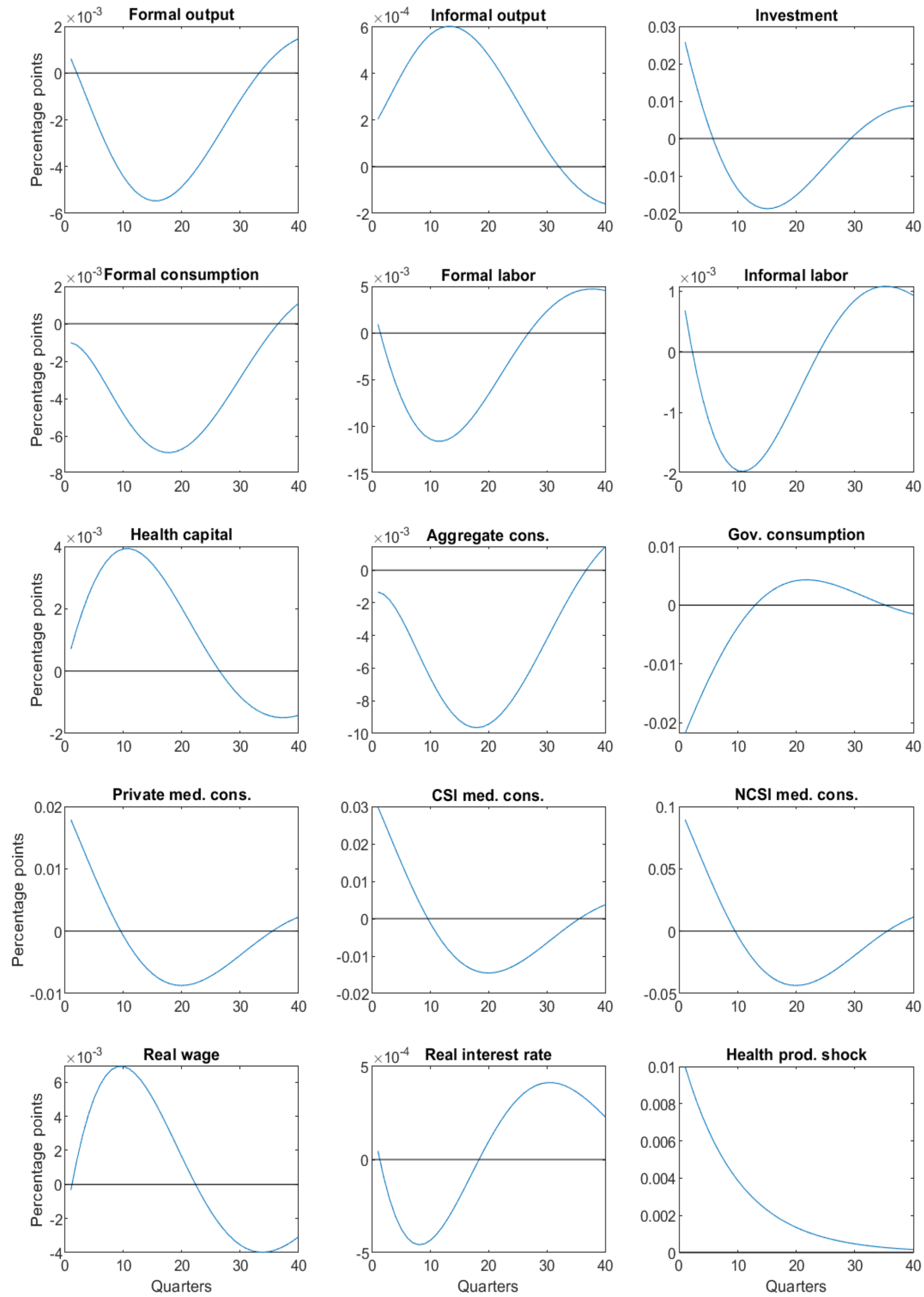

Figure 3.2: Impulse responses under a positive 1% shock to health investment productivity.

Production factor prices follow opposite trajectories. With the shock, there is a decrease in the real wage due to the relative excess of capital, but gradually it begins to fall as formal labor still rises both forms of capital are accumulated. Real interest rate initially undergoes a slight positive change, given the increase in the marginal productivity of capital, but later decreases below its steady-state value due to the process of capital accumulation.

The shock to the private medical provider cost function increases the price of the good it provides, such that demand falls by in 0.2% and then gradually rises. At the same time, the demand for public medical goods increases. This is the expected effect since we considered a health production function of perfect substitutes. That increase in the demand for public medical goods implies a reduction in the government non-medical consumption, which returns to its steady-state level almost 40 periods after the shock.

That is the main difference in the transitional dynamics of our model between public and private medical provider costs shocks. When the shock occurs in the private sector, demand by public medical providers goods increase and government non-medical consumption falls, whereas when the shock occurs in the public sector, demand by private medical services increase and government non-medical consumption grows.

When a positive cost shock occurs in some medical services firm, the demand for goods for that firm is reduced and that of other medical goods increases. The rise in the price of this type of goods generates a reduction in the accumulation of health capital, which reduces the marginal productivity of labor, forcing people to work more in the formal sector even when the real wage has been reduced. Likewise, in the informal sector, the increased cost of investment in health generates an increase in the labor factor to compensate for the gradual reduction in health capital. These effects imply a reallocation of resources to the formal sector of the economy since the increased cost of health capital investment can be compensated by hiring physical capital.

3.2 Discussion about formal productivity shock

As the impulse-response analysis shows regarding the formal productivity shock, our model finds that formal output falls whereas informal output rises, and there is a fall in labor in both the formal and informal sectors.

In the Fernández and Meza (2015) model, when a positive formal productivity shock occurs, both types of work increase, but because of the incomplete pass-through, eventually more and more people decide to work in the formal sector because relative competitiveness increases in this sector, which generates the reallocation of the labor force between sectors. However, in our model there is not such reallocation effect since labor time falls in both the formal and informal sectors even with low levels of correlation of the shocks between sectors.

Here, in response to a formal productivity shock with pass-through to the informal sector,

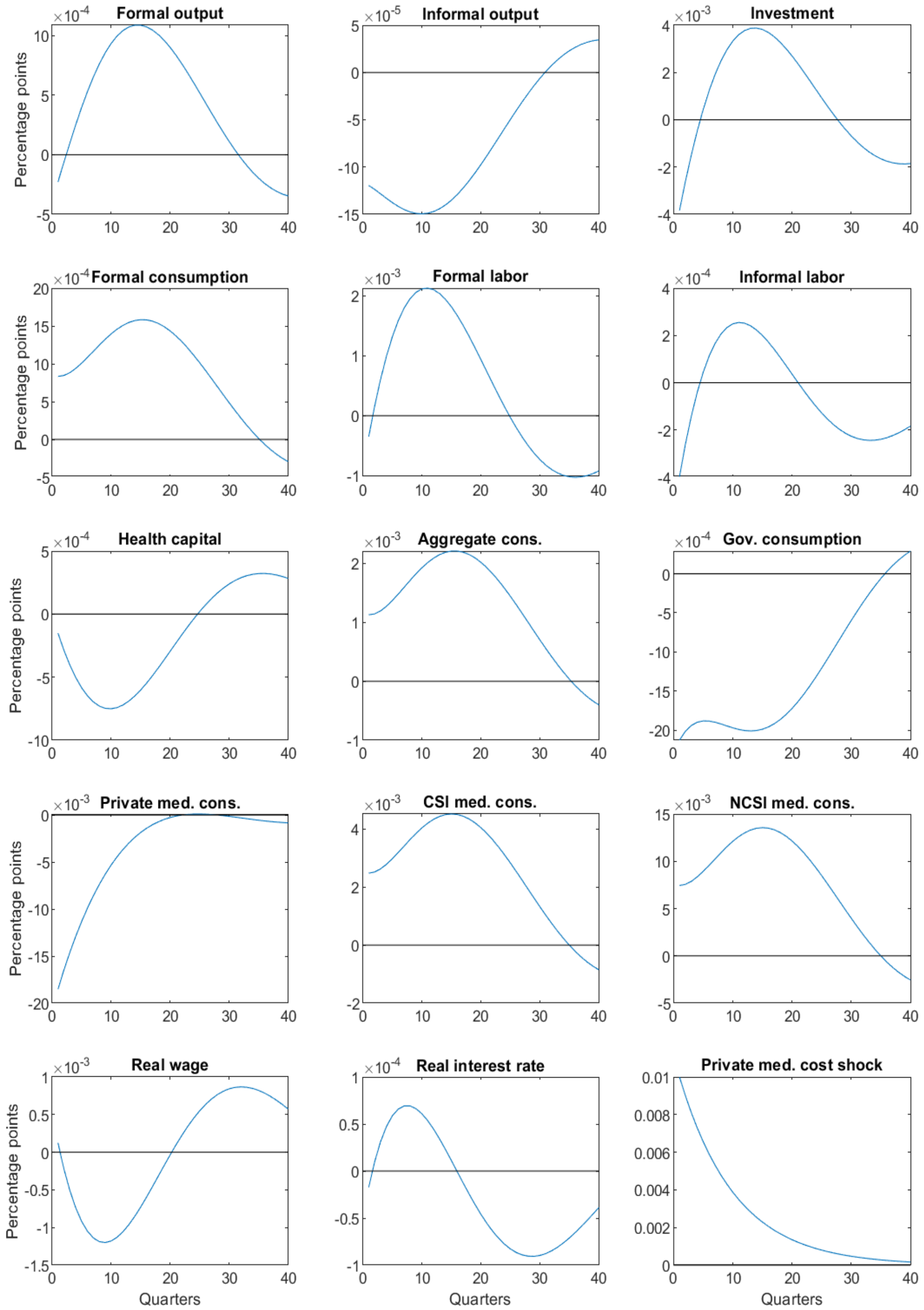

Figure 3.3: Impulse responses under a positive 1% shock to private medical provider cost function.

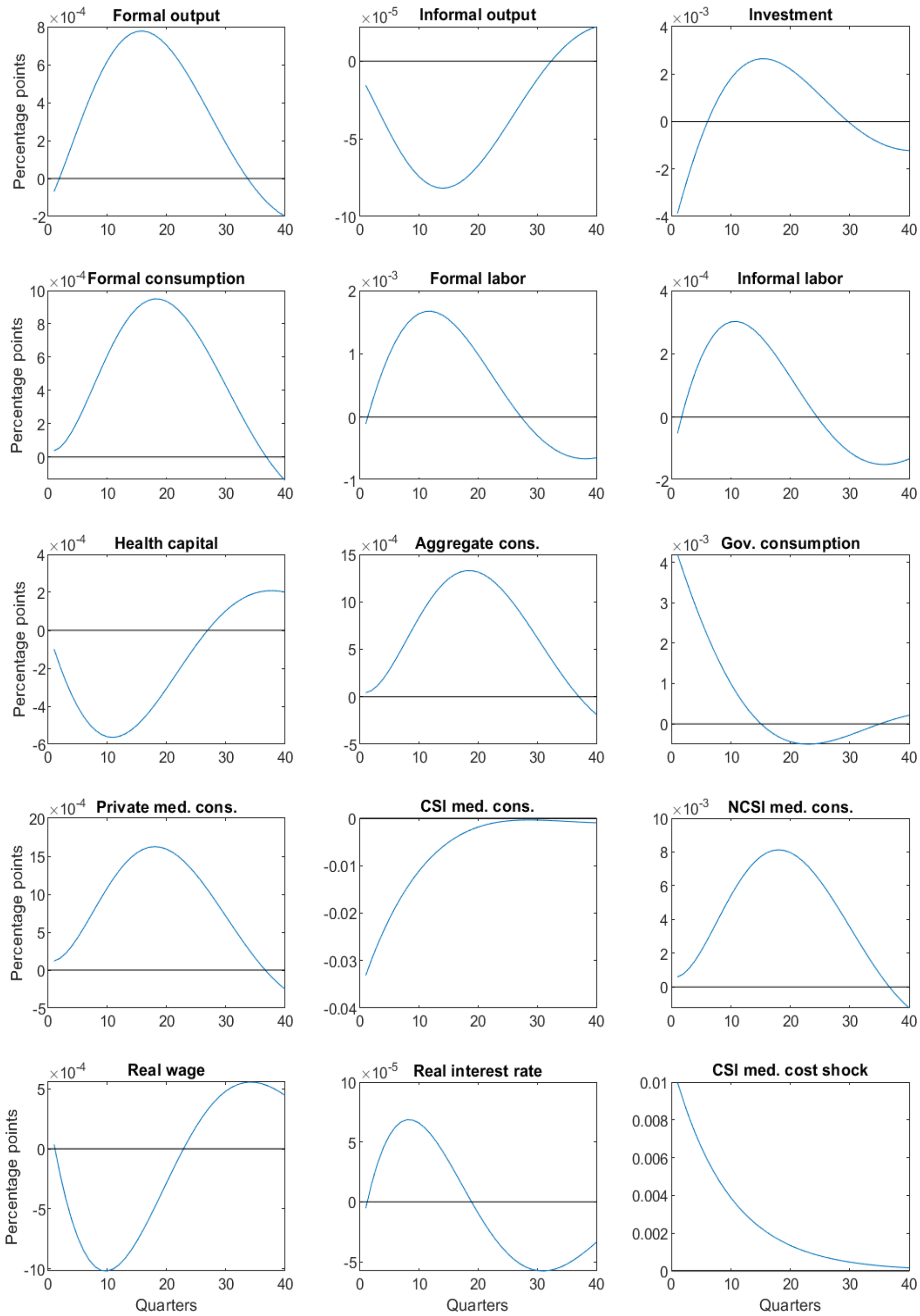

Figure 3.4: Impulse responses under a positive 1% shock to CSI medical provider cost function.

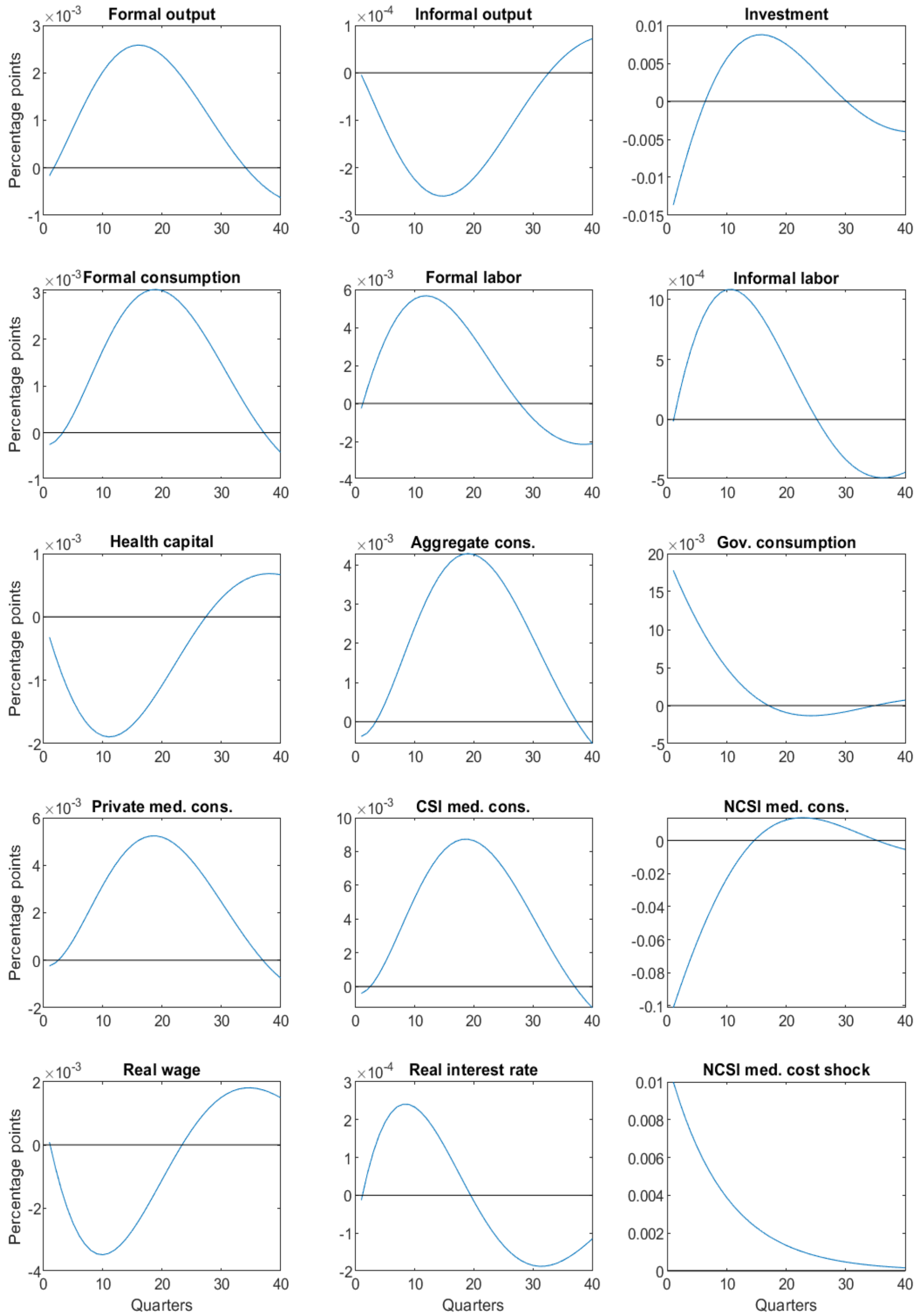

Figure 3.5: Impulse responses under a positive 1% shock to NCSI medical provider cost function.

households find it optimal to invest in their health not through higher spending on medical services but through a reduction in working time in both sectors (especially in the formal sector). However, the increase in productivity more than offsets the fall on labor in the informal sector making grow the informal production. The fall in the labor factor as an input in formal production reduces the marginal productivity of capital and therefore decrease the real interest rate, whereas it increases the marginal product of formal labor and raises the real wage. These effects imply less investment and accumulation of physical capital and a reduction in formal output. Eventually, as the shock wears off medical expenditures and physical capital investment increase such that formal production returns its steady-state value again.

To try to understand this effect, remember the labor supply conditions in both sectors derived in Chapter 1:

$$-\frac{u_{n^F}}{u_{c^F}} = w_t(1-\tau_y) - \frac{p_t^{PT} D_{n^F} h_t}{H_{m^{PT}}}, \tag{3.1}$$

$$-\frac{u_{n^I}}{u_{c^I}} = f_{n_t^I} - \frac{p_t^{PT} D_{n^I} h_t}{p_t H_{m^{PT}}}. \tag{3.2}$$

We can see from (3.1) that in order to have an increase in formal labor supply as a result of a formal productivity shock, we need that the increase in the real wage be significant enough to compensate the marginal loss in health due to greater working time and the marginal product obtained from investing in medical goods. Similarly, from (3.2) we can see that the marginal rate of substitution between informal work and informal consumption depends on the marginal product of informal labor and the ratio of marginal depreciation from informal labor to marginal medical good contribution, weighted by the ratio of relative prices.

In this case, the increase in the real wage is not large enough to compensate the marginal loss in health due to greater formal working time, and that is why household choose to invest in health capital by reducing formal work. This means that the effect of increasing health capital outweighs aggregate labor supply, so that households reduce both formal and informal activities.

These results depend crucially on the assumption of incomplete pass-through from productivity shocks in the formal sector to the informal sector. As shown in Appendix B, when the shocks are not correlated between sectors, both formal and informal output increase on impact but medical expenditures encompasses a considerable part of the benefits of the productivity shock since, through this investment in health capital, individuals can increase both types of production. This effect is reinforced by reducing formal working hours, as this also contributes to having a higher health capital in the following periods. This combined effect seems to explain the initial fall in formal employment in that case.

Certainly, reducing labor time to improve one's health at the sacrifice of aggregate consumption seems too large to be believable (near 3%). One possible explanation of this can be found in how labor enters health capital accumulation. In our specification, labor does not enter the health production technology, so by the health law of motion, health capital improves when labor time reduces. Including the labor time in the production technology in a Cobb-Douglas function, such as He et al. (2016), could help mitigate the gains in health derived from lower working time.

3.3 Sensitivity analysis

In this section we analyze the sensitivity of our results to different parameter values. In particular, we consider the implications of different values for the wage elasticity of labor χ and sum up the remaining sensitivity analysis presented in the Appendix A. In all cases, the solid blue line represents the benchmark parameterization, and the dashed lines represent the alternative parameters.

Figures 3.6–3.10 show the impulse responses of our model to each of the shocks analyzed in the previous section for three different values of the parameter related with the Frisch elasticity of labor supply. These alternative parameters are $\chi = 2$ and $\chi = 1.2$, i.e. one above and one below our benchmark calibration. The higher the Frisch elasticity parameter, the more willing are people to work if the wage increases.

As we can see from Figure 3.6, our results do not change considerably for different values of χ in the face of a productivity shock in the formal sector. Even with the higher value $\chi = 2$, the initial rise in wage due to the shock does not generate a significant change in formal labor supply from the baseline parameterization.

Concerning the health investment productivity shock, Figure 3.7 shows that results vary little for different values of χ. The most significant change concerns the response of informal output. With our higher value of $\chi = 2$, we see a greater response on impact but a faster decline towards its steady-state value.

The same is true for the impulse responses to a cost shock in every medical firm for different values of the Frisch elasticity parameter. In each case, most significant changes are related with informal output and labor response. The higher value of χ, the greater response on impact but a faster convergence towards its steady-state value.

In Appendix A we present the sensitivity figures concerning the parameter relative to the elasticity of substitution between formal and informal goods μ, the exogenous health rate of depreciation δ_h, the pass-through parameter κ, and the contribution to health of each of the medical goods ξ_{PT}, ξ_C, and ξ_{NC}. The results of the model seems to be very sensitive to the choice of μ, but robust to the exogenous health rate of depreciation, the degree of pass-through between shocks, and the health contribution parameters.

We compare our baseline results with elasticity of substitution between formal and informal goods of 12 and 2, implied by values of μ equal to 11/12 and 0.5, respectively. For low elasticities, formal and informal goods are not good substitutes implying that the informal activities cannot easily replicate formal goods. The higher parameter is similar to the baseline

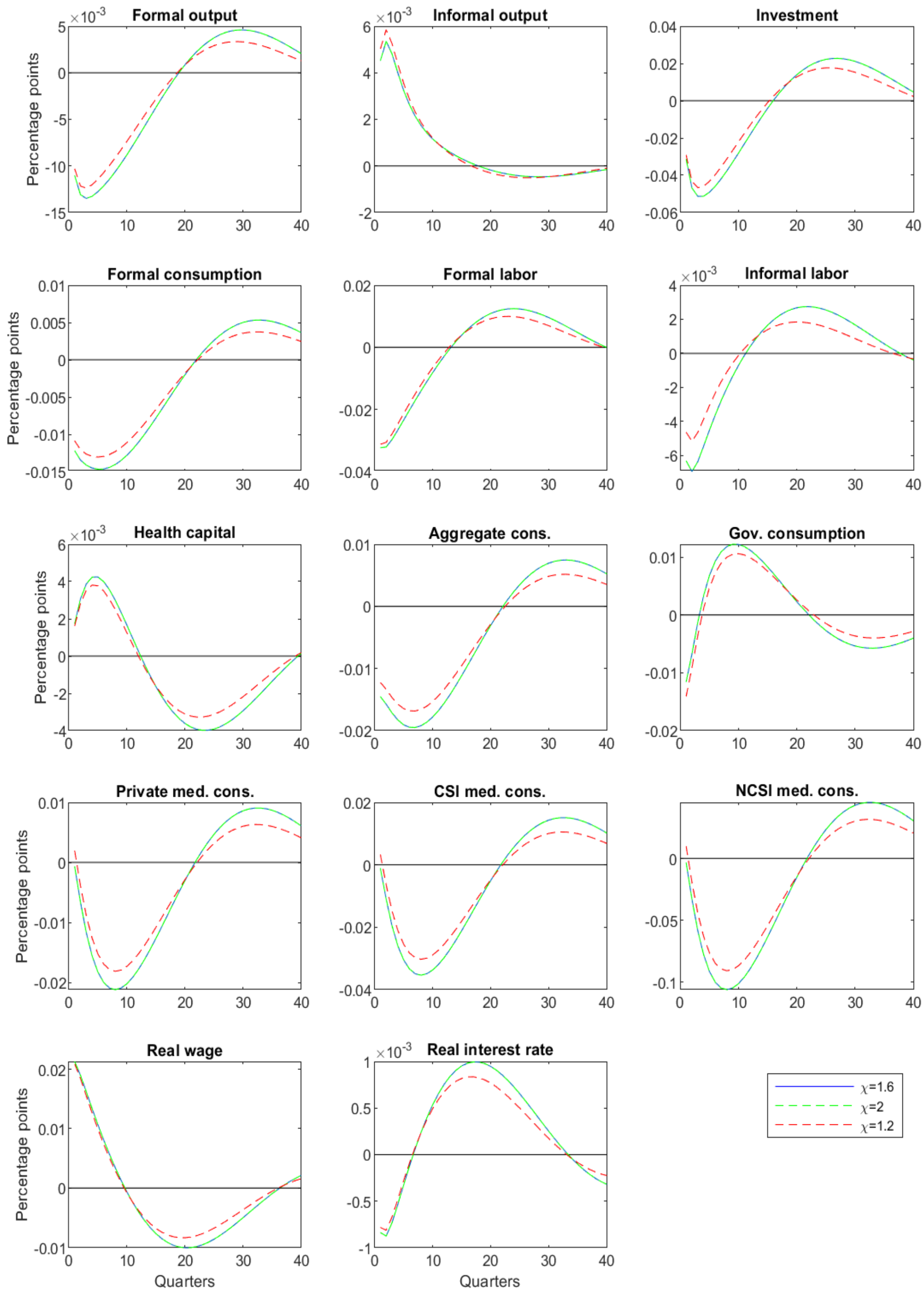

Figure 3.6: Impulse responses under a positive 1% shock to formal technology for different values of χ.

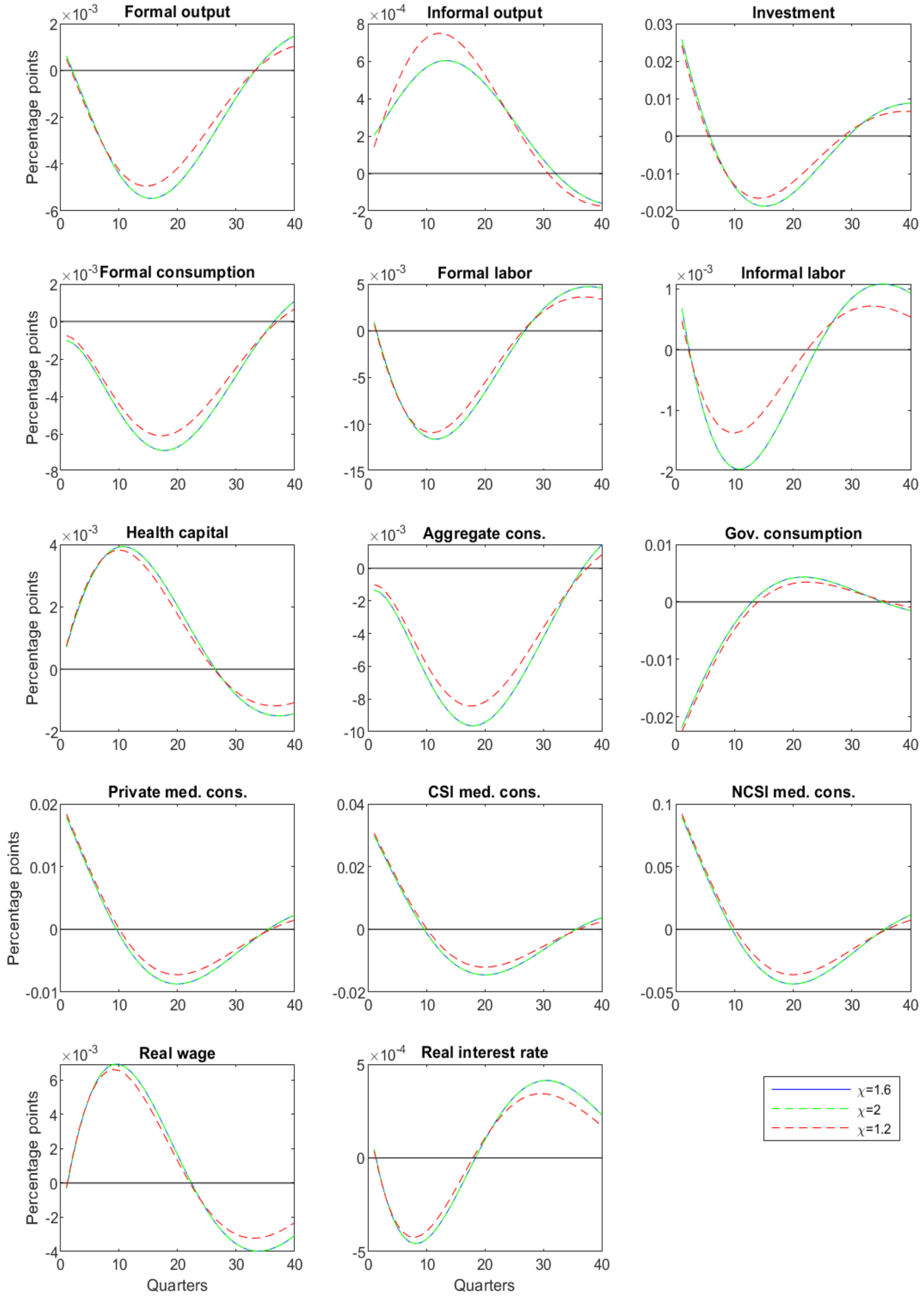

Figure 3.7: Impulse responses under a positive 1% shock to health investment productivity for different values of χ.

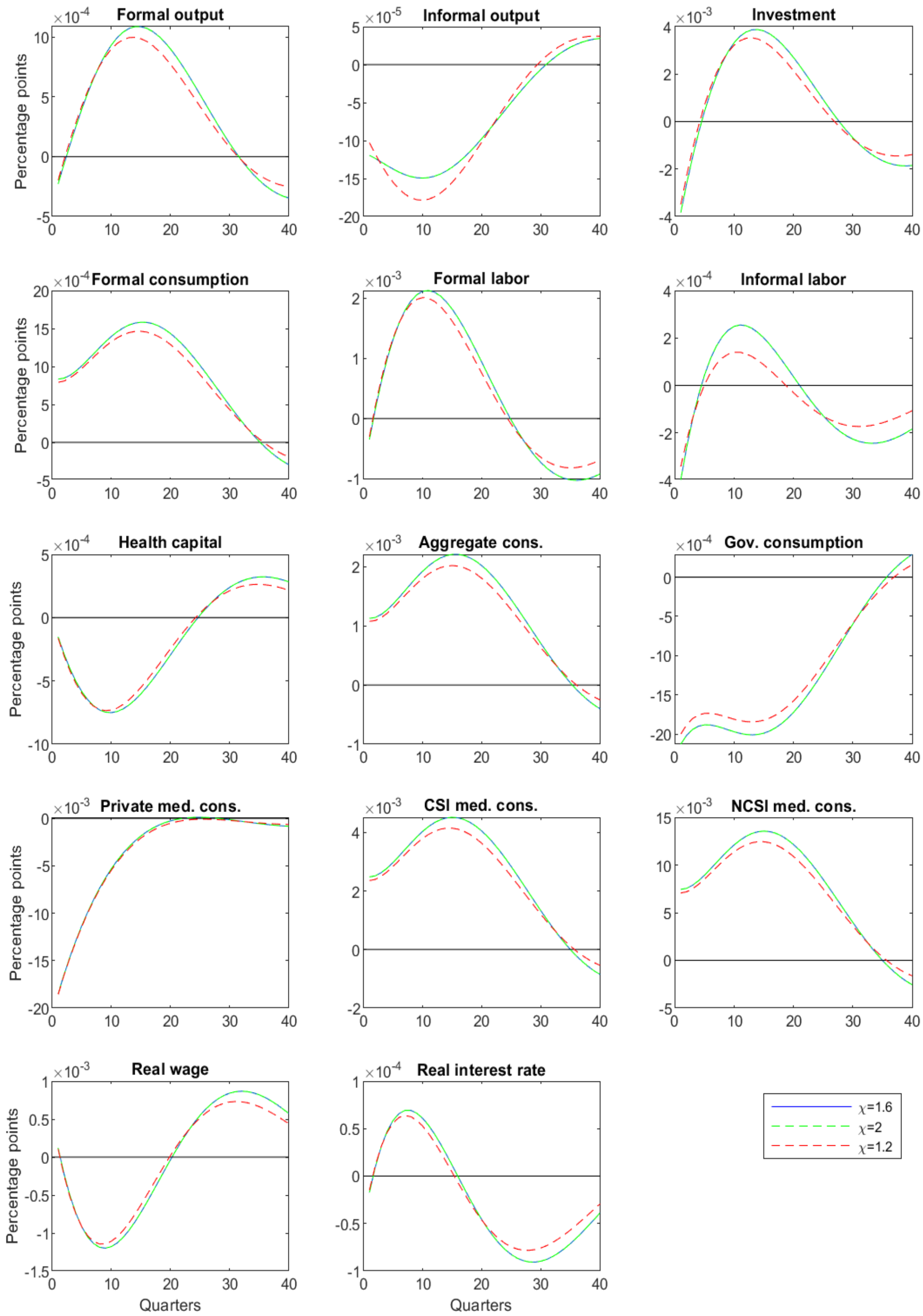

Figure 3.8: Impulse responses under a positive 1% shock to private medical provider cost function for different values of χ.

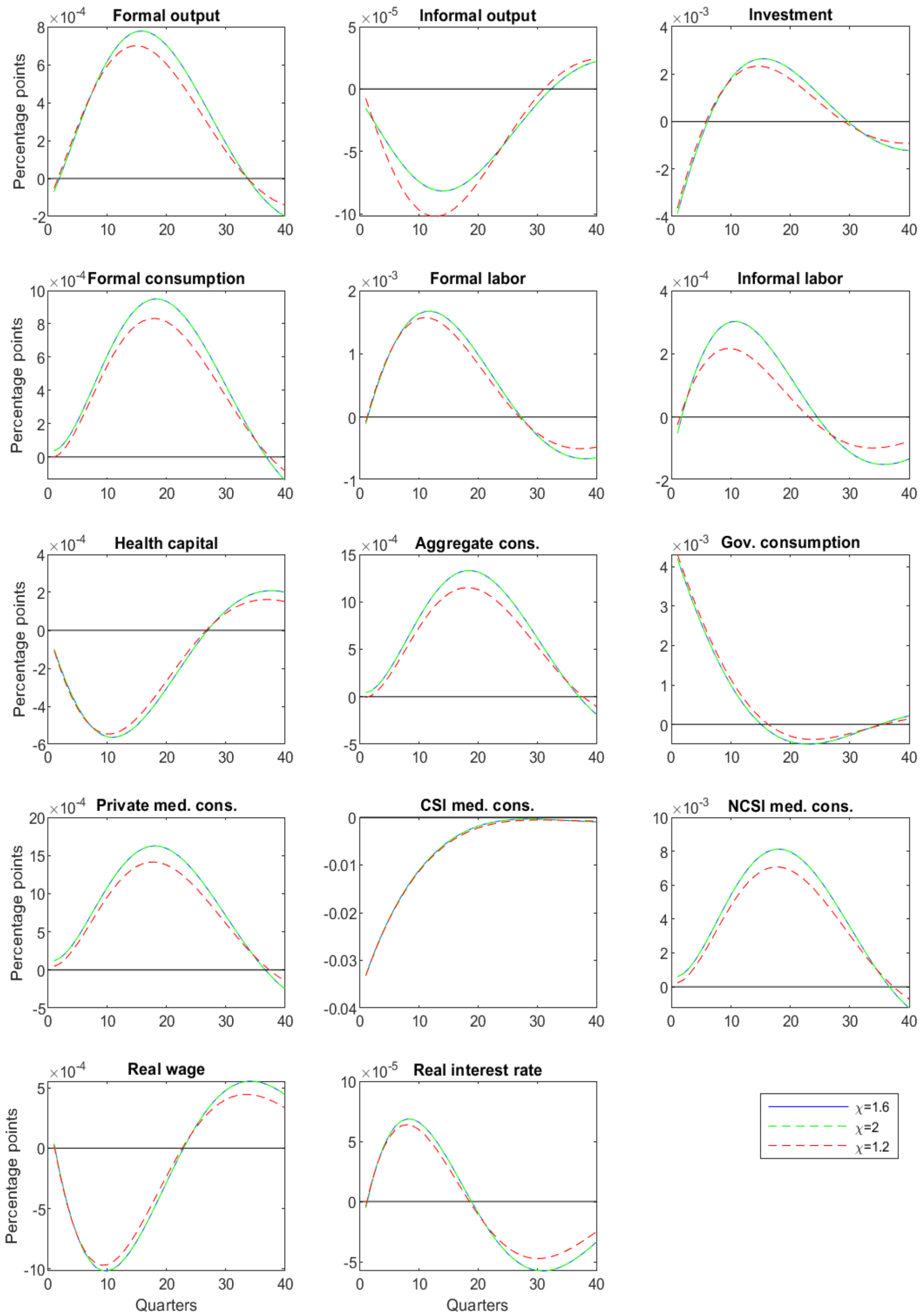

Figure 3.9: Impulse responses under a positive 1% shock to CSI medical provider cost function for different values of χ.

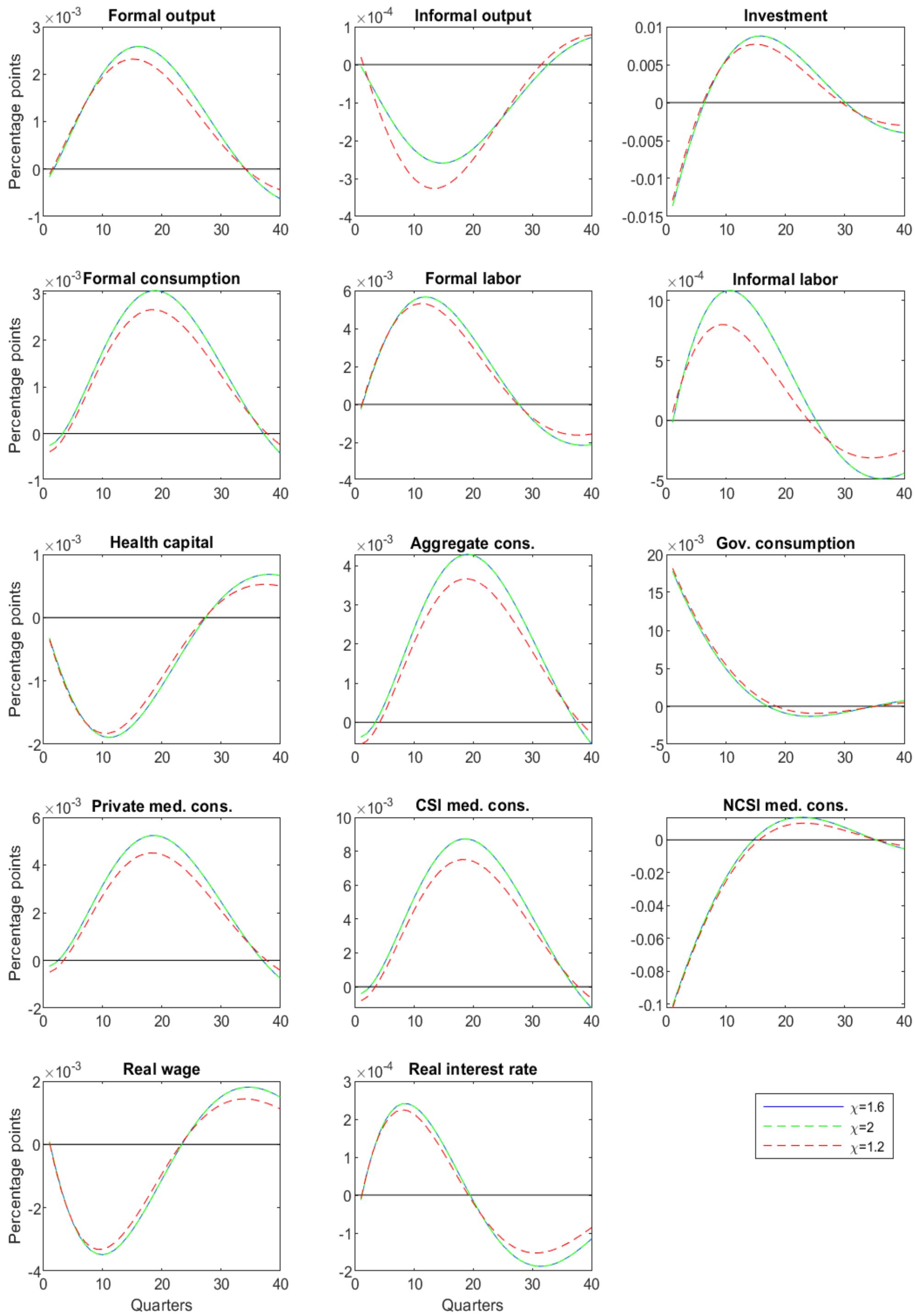

Figure 3.10: Impulse responses under a positive 1% shock to NCSI medical provider cost function for different values of χ.

selection and do not modify the results significantly. On the other hand, the lower elasticity of substitution implies considerably smoother trajectories for all shocks with some remarkable differences from the baseline parameterization. When a productivity shock arises in the formal sector, the low elasticity of substitution implies that formal goods consumption falls only by a minimal proportion generating an initial increase in the aggregate consumption. In this case, both the medical expenditure and physical capital investment increase on impact to encompass the productivity gains of the shock and avoid the fall in the formal production.

We compare our baseline results with an exogenous health rate of depreciation of 0.0025 and 0.04, which imply an annual depreciation of the health stock of 1% and 16%, respectively. In all cases the results are very similar to the benchmark parameterization.

We choose choose two lower than baseline values of the pass-through parameter κ to compare our results. In the first case, we set an arbitrary value of 0.1 to see what happens with a very low degree of pass-through. The results seem robust since only the smoothness of the impulse-response change without significative qualitative differences from the baseline parameter in every shock. But in the extreme an unrealistic case of zero pass-through the main results change considerably. We analyze in deep this situation in Appendix B.

Finally, we analyze the comparative of our results to different choices of the contribution to health parameters of each medical good ξ_{PT}, ξ_C, and ξ_{NC}. We compare with settings where the private medical good and the CSI medical good provides the same marginal contribution to health but with different contribution for the NCSI medical services. In all cases, the results are very similar to the baseline parameterization.

Conclusion

The recent line of research on the macroeconomic effects of healthcare has successfully identified several factors that drive the growth of the medical sector, such as the rising income levels, the introduction of new medical technologies, increasing access to and generosity of health insurances, and the aging of the population. This thesis has attempted to contribute to this literature by considering how labor status (formal or informal) affects the growth of the medical sector, based on the fact that this condition is critically tied to the financing of medical services in developing countries like Mexico.

We build a model of aggregate fluctuations where households choose how much labor to allocate to formal and informal activities and consume goods produced in each sector. Households accumulate a health capital stock that can be improved by medical expenditures but depreciates with labor and exogenous forces. Health stock works as a production input in both sectors. We analyzed three sources of uncertainty in the model: first, a shock to the aggregate productivity in the formal sector, second, a health investment productivity shock, and third, shocks to the cost function of each medical provider.

We found that in response to a positive formal productivity shock, households find it optimal to invest in their health not through higher spending on medical services but through a reduction in working time, especially in the formal sector. This effect happens when the increase in the real wage due to productivity shock is not sufficient to compensate the marginal loss in health for greater formal working time, so households choose to invest in health capital by working less in both sectors.

Concerning the health capital investment shock, our model does a reasonably good job of replicating the increase in medical expenditure carefully studied in the literature. In this case, we obtain the traditional transmission mechanism, i.e., as medical inputs become more productive, households reduce their labor time to increases health investment. This effect increases formal and informal output but with a reallocation of resources from labor market to medical sector. Government non-medical consumption decreases to finance the greater demand for public medical services.

Finally, we showed that when a positive cost shock occurs in a medical services firm, the demand for goods for that firm is reduced, and that of other medical goods increases. This result follows from the perfect substitutes production function that we have assumed. The increase in the price of medical services implies a reduction in the accumulation of health capital, which reduces the marginal productivity of labor and physical capital, forcing people to work more in the formal sector even when the real wage has been reduced. Likewise, in the informal sector, the increased cost of investment in health generates an increase in the labor factor to compensate for the gradual reduction in health capital. These effects imply a reallocation of resources to the formal sector of the economy since the increased cost of health capital investment can be compensated by hiring physical capital.

All our results seems robust to many of the parameters that we have chosen. Different values for the Frisch elasticity of labor, the exogenous health rate of depreciation, and the contribution to health of each of the medical goods do not modify our main conclusions. However, our results do not hold in the extreme an unrealistic case of zero pass-through between the formal and informal sectors. Similarly, when the degree of elasticity of substitution between formal and informal goods is low, our results seem week in the face of a formal productivity shock but robust for all other shocks.

For future work, the way social security fits into our model could be improved. One shortcoming of this is that households receive government contributions regardless of the labor sector they belong to. Although these schemes may coexist within the same household in real life, it might be convenient to restrict or better link each social security scheme with employment's formal or informal status. One way to implement that setting could be with heterogeneous households, an idea that has already been explored by Kelly (2020), whose individuals differ according to age, skill level, and access to employer-provided health insurance for the United States. Similarly, we could explore the interaction between health and education since there is strong evidence about the importance of education improving people's health in the last century. Another possible extension is relaxing the assumption of perfect competition in the medical and labor markets.

Despite advances in understanding the determinants of health spending at the aggregate level, we need to delve more deeply into how these interact with other relevant macroeconomic variables such as unemployment, market concentration, or medical goods provision. Identifying these relationships is essential for the successful design and implementation of any health reform, which is of critical importance for many emerging economies.

Appendix A

Sensitivity figures

In this appendix we present the sensitivity figures complementary to chapter 3.

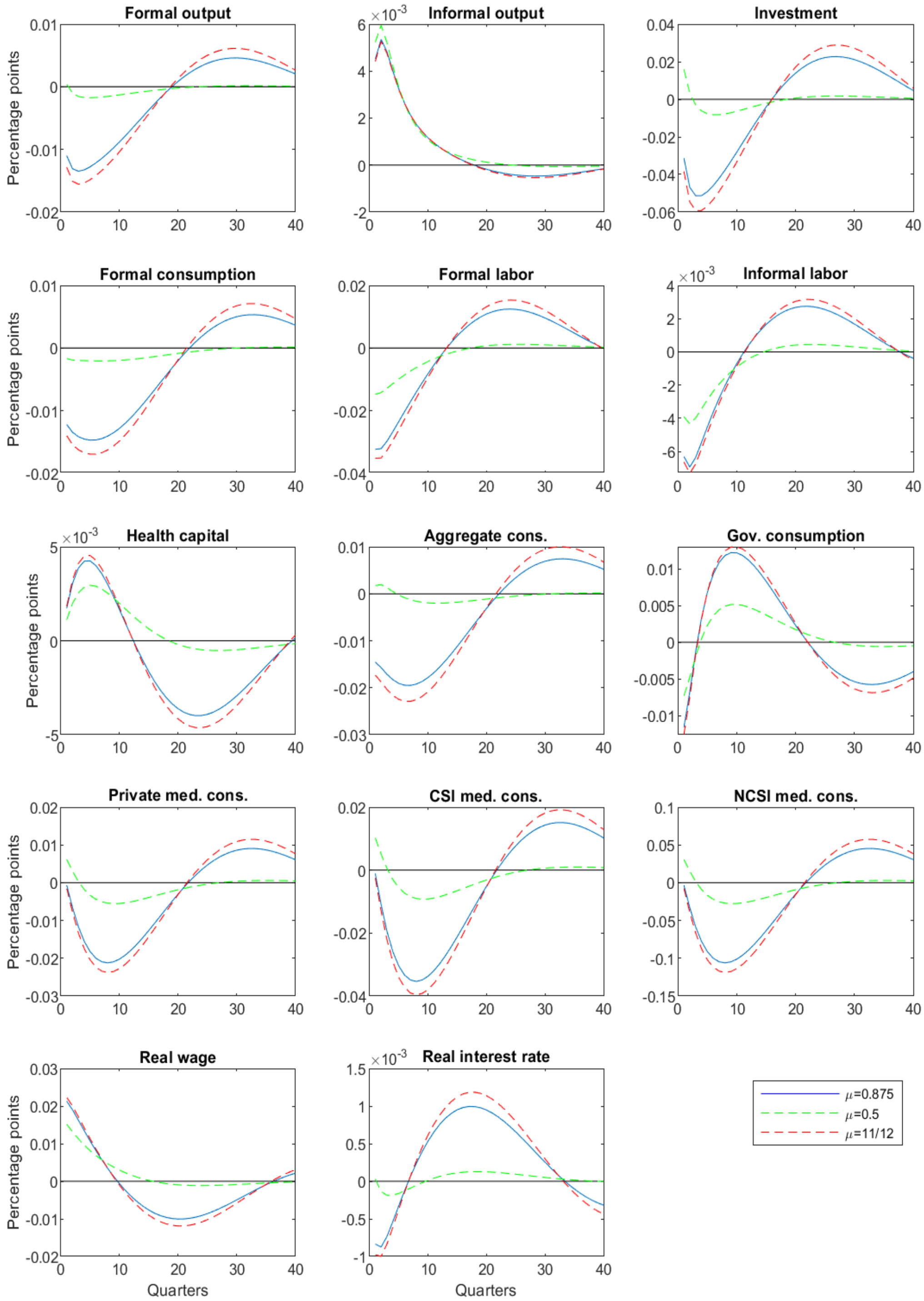

Figure A.1: Impulse responses under a positive 1% shock to formal technology for different values of μ.

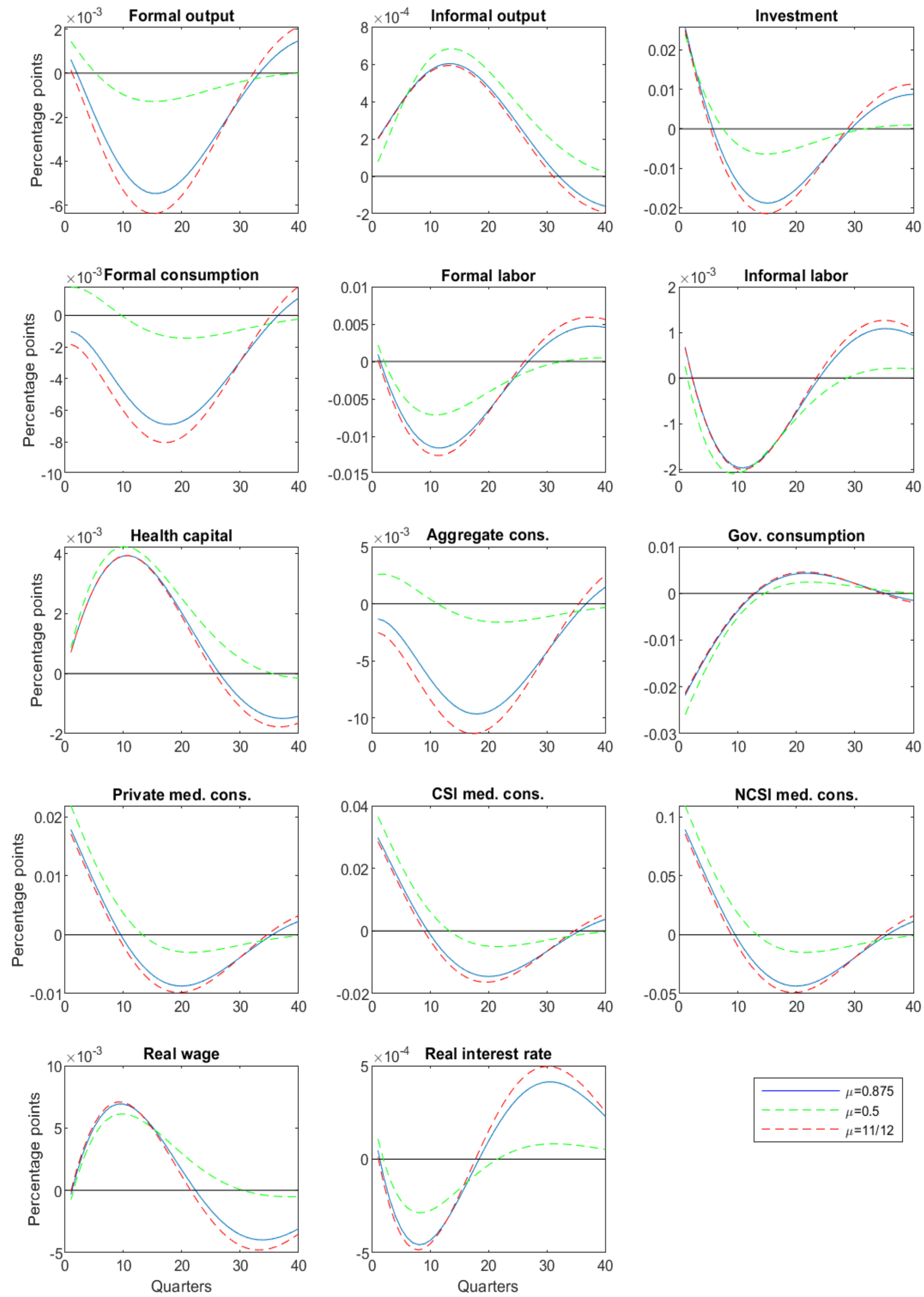

Figure A.2: Impulse responses under a positive 1% shock to health investment productivity for different values of μ.

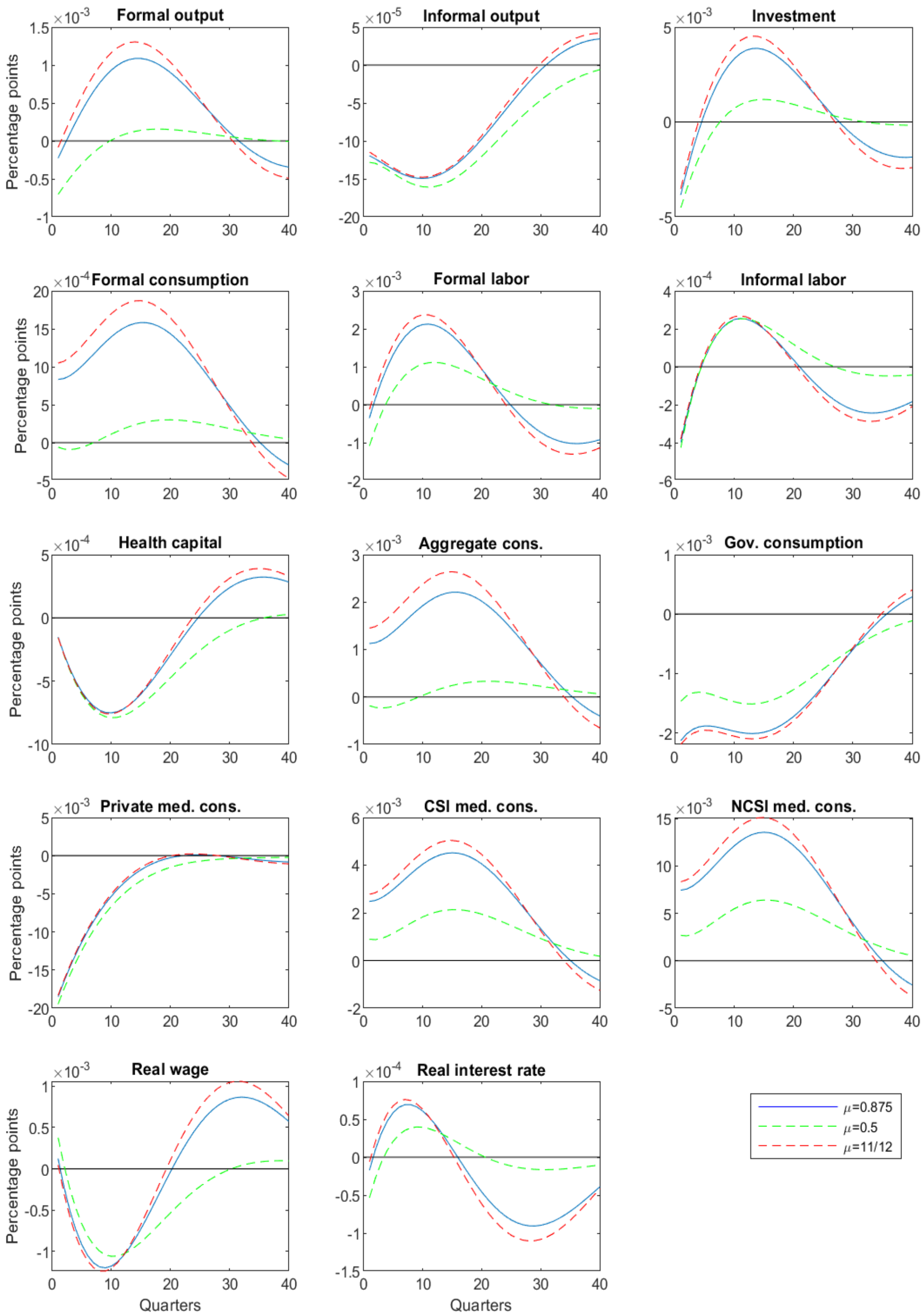

Figure A.3: Impulse responses under a positive 1% shock to private medical provider cost function for different values of μ.

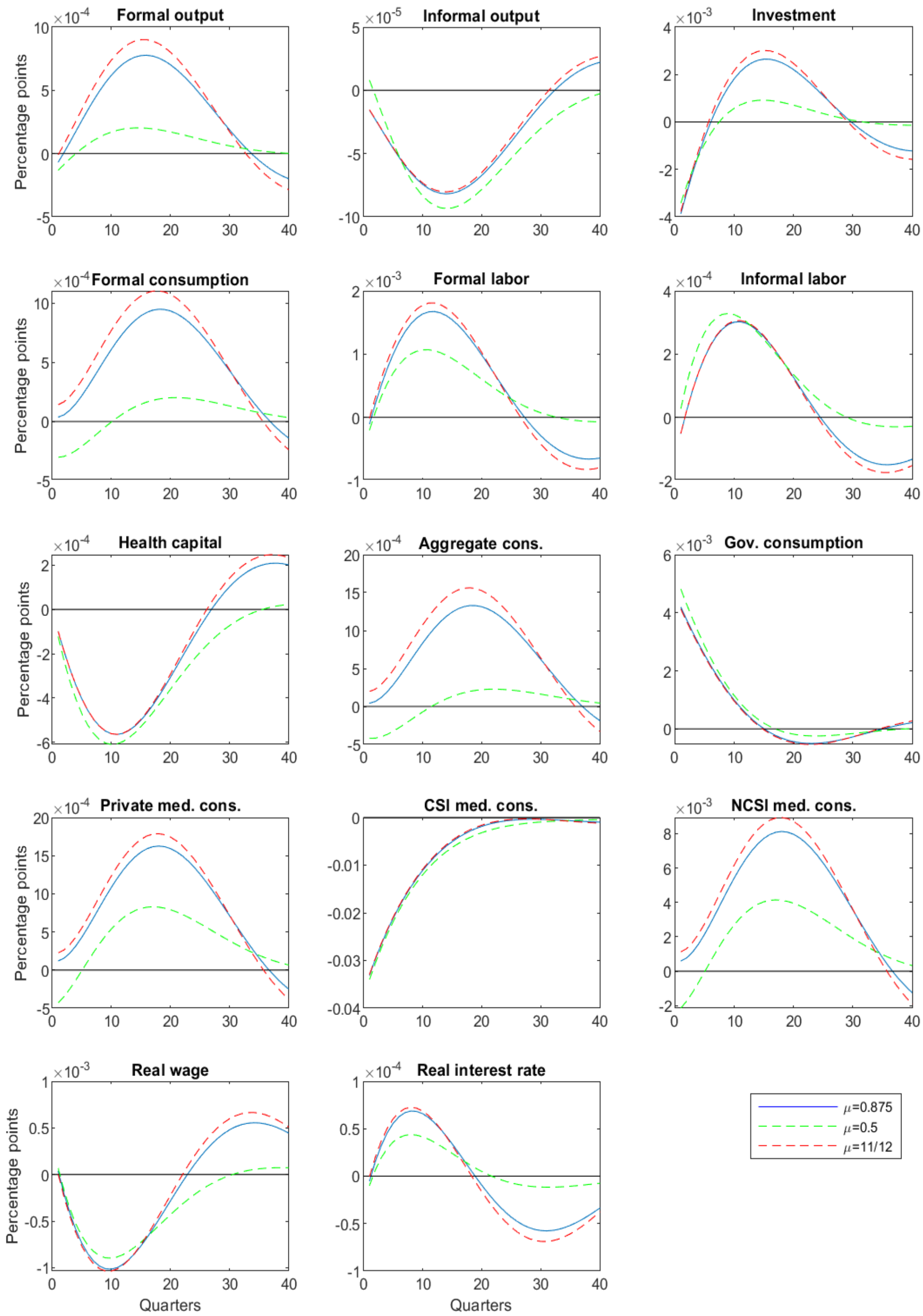

Figure A.4: Impulse responses under a positive 1% shock to CSI medical provider cost function for different values of μ.

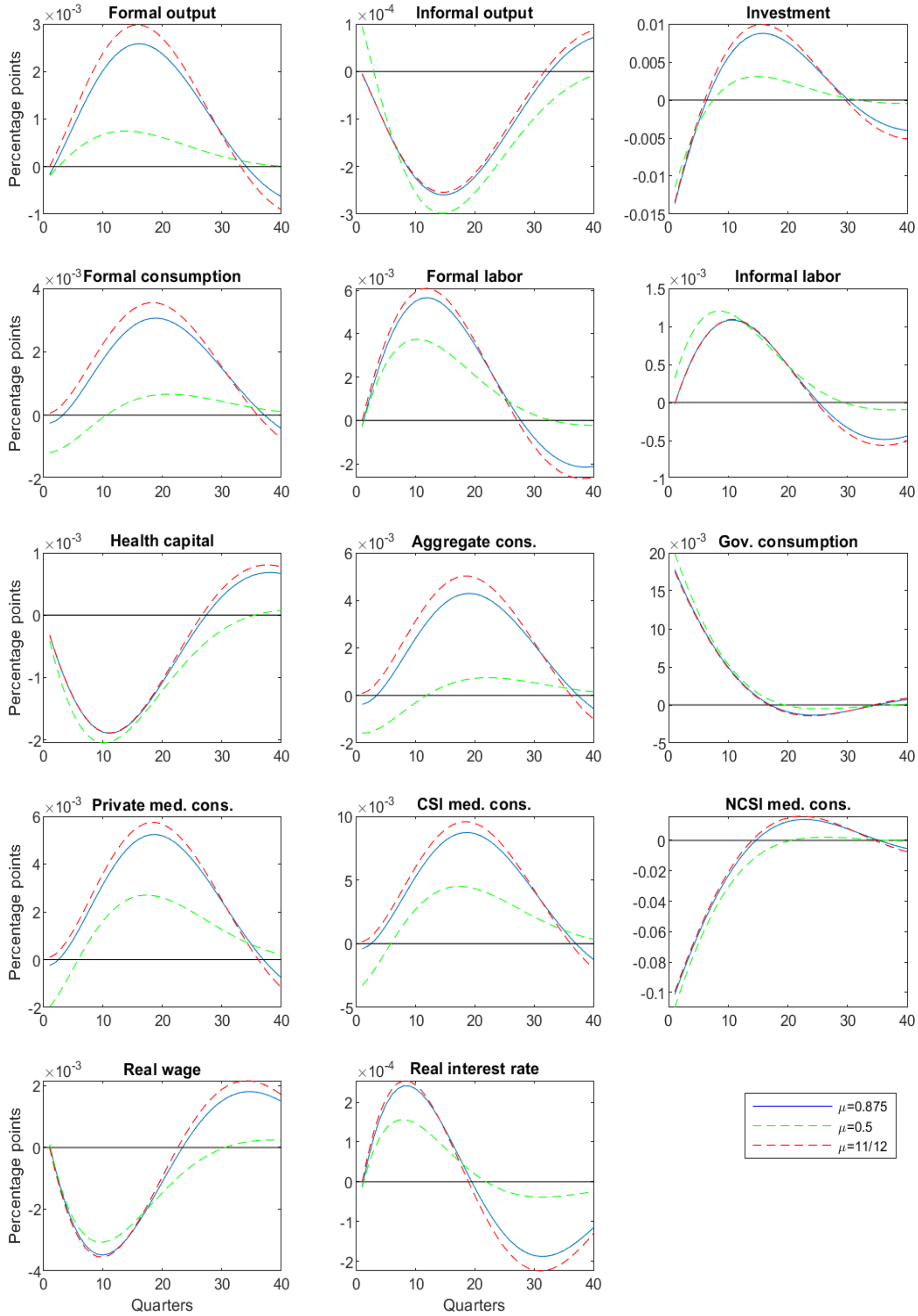

Figure A.5: Impulse responses under a positive 1% shock to NCSI medical provider cost function for different values of μ.

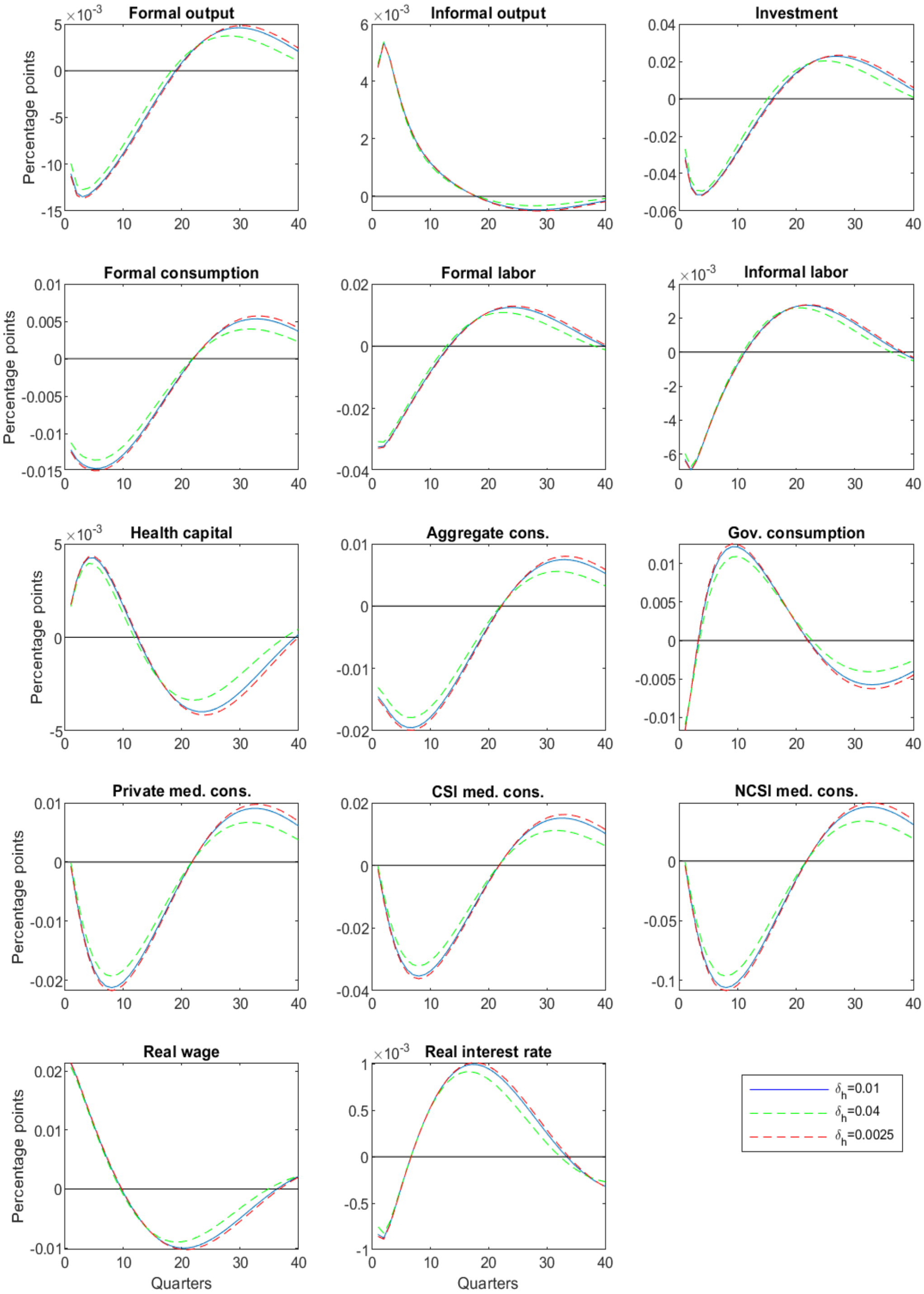

Figure A.6: Impulse responses under a positive 1% shock to formal technology for different values of δ_h.

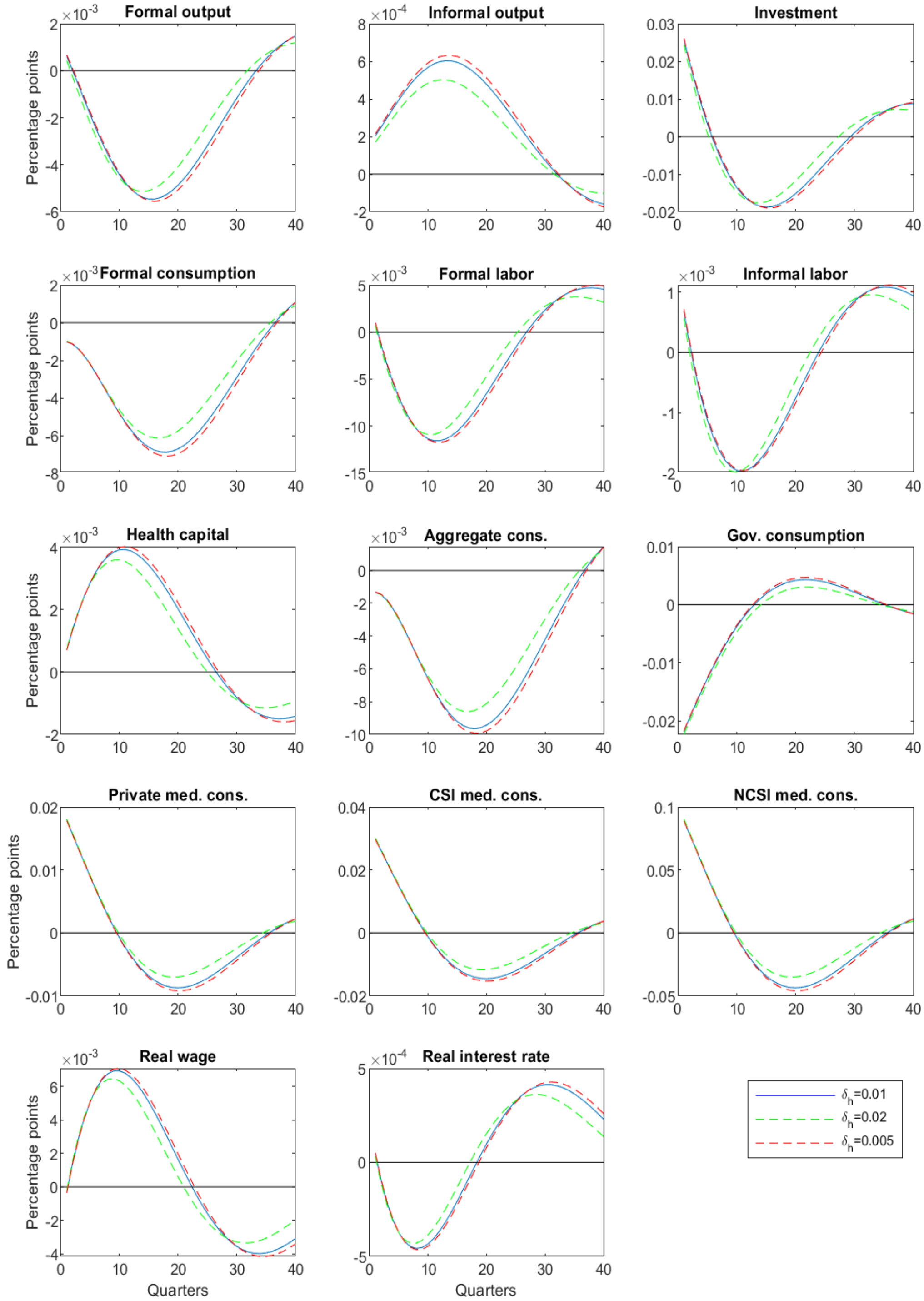

Figure A.7: Impulse responses under a positive 1% shock to health investment productivity for different values of δ_h.

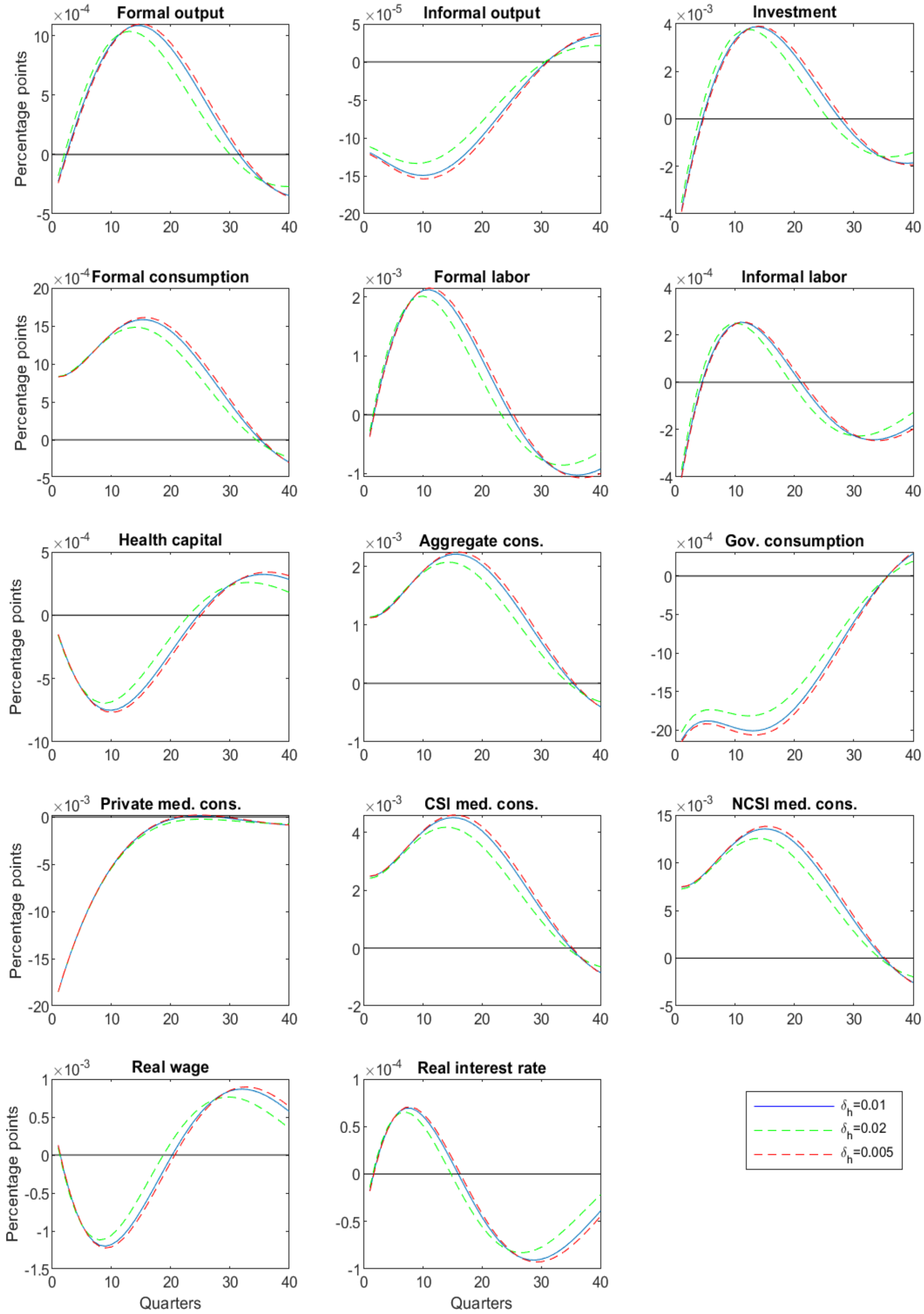

Figure A.8: Impulse responses under a positive 1% shock to private medical provider cost function for different values of δ_h.

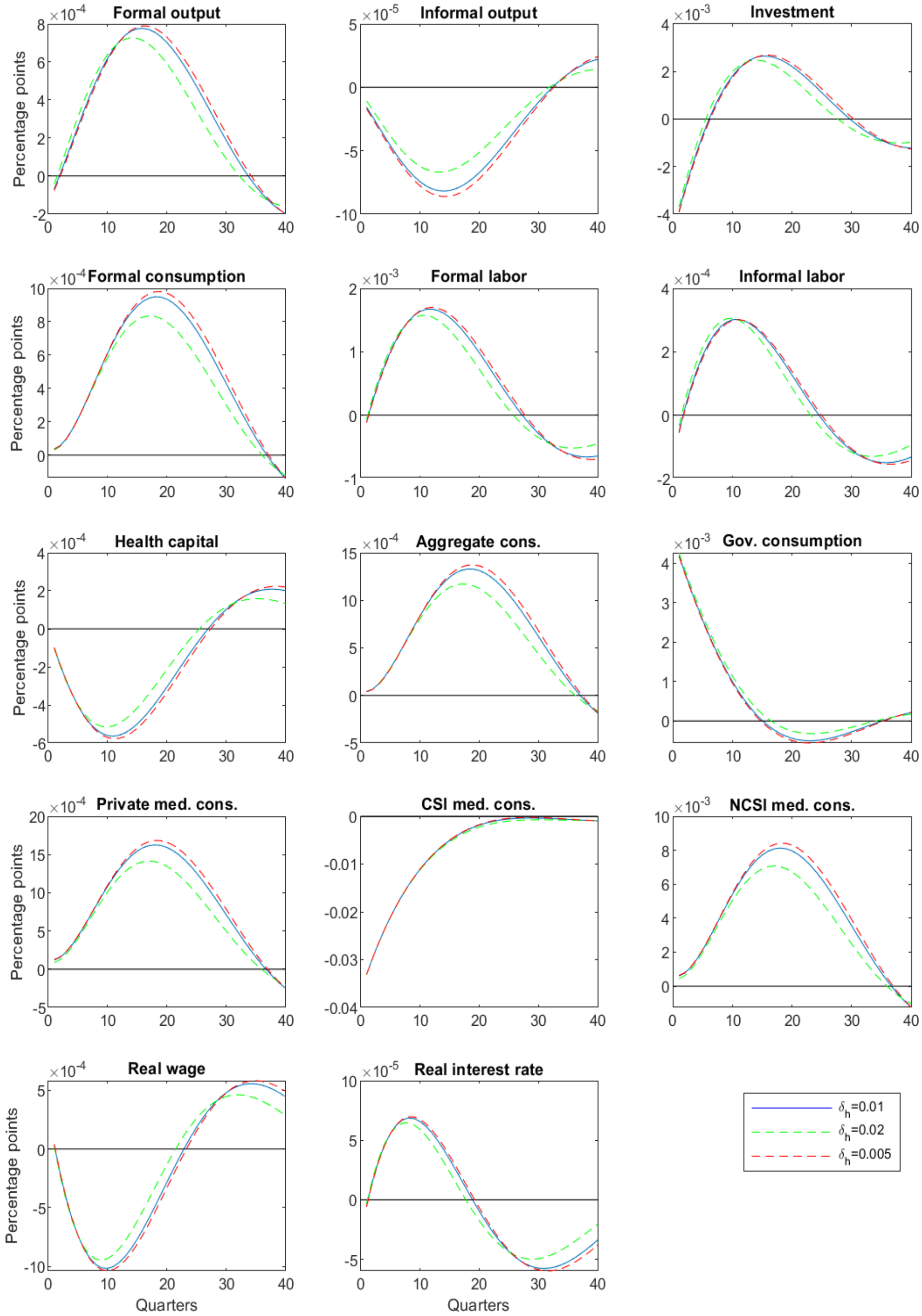

Figure A.9: Impulse responses under a positive 1% shock to CSI medical provider cost function for different values of δ_h.

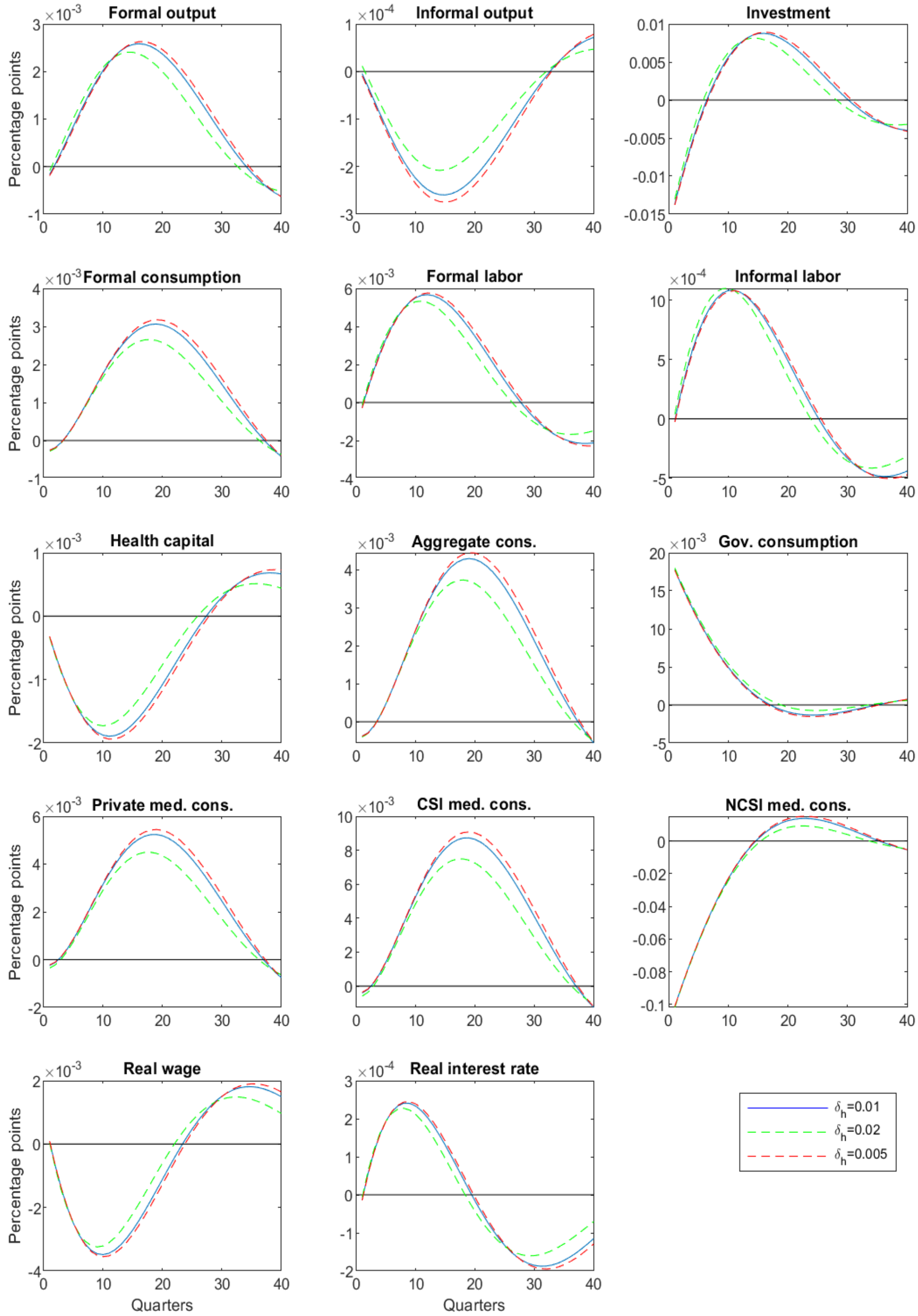

Figure A.10: Impulse responses under a positive 1% shock to NCSI medical provider cost function for different values of δ_h.

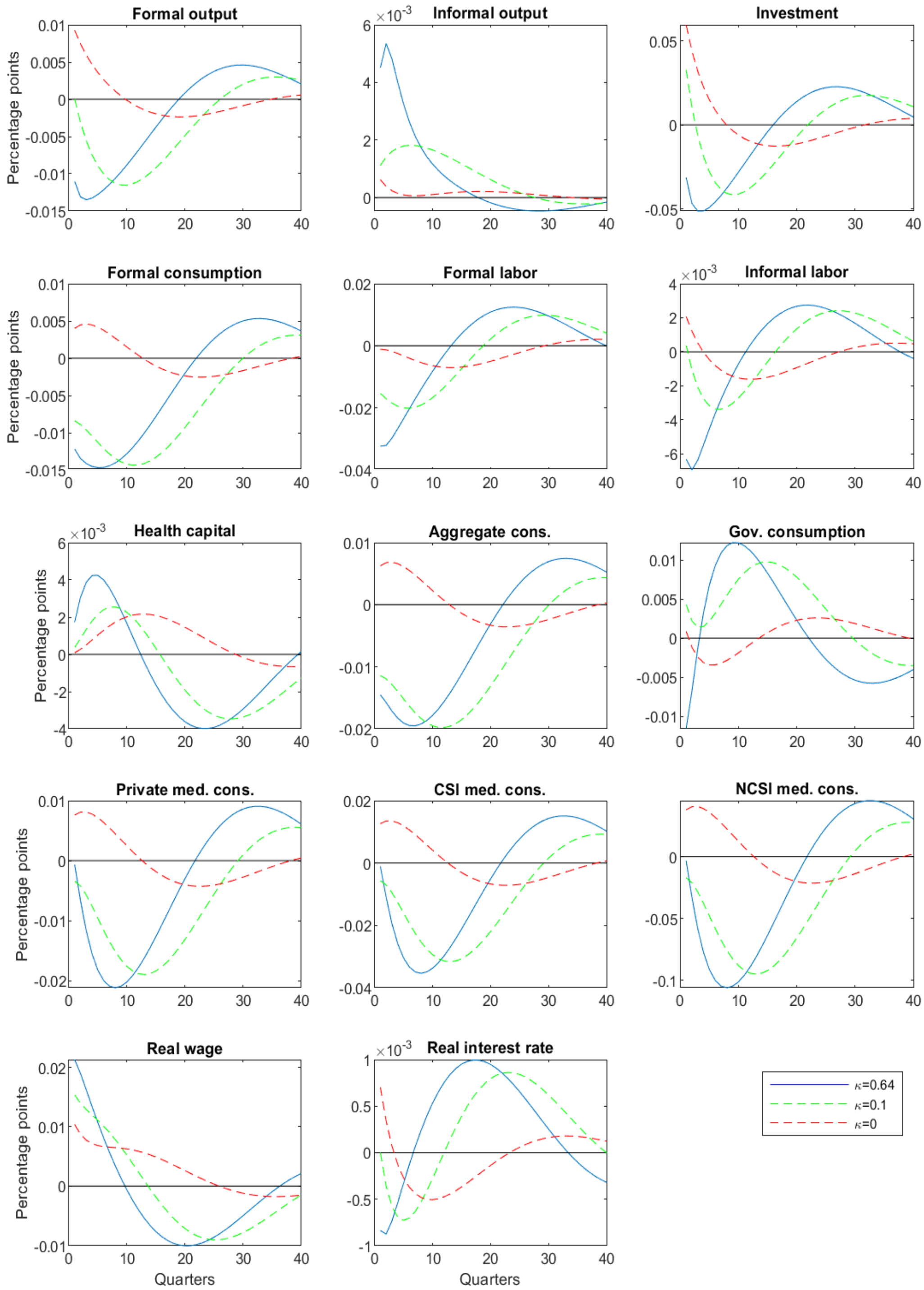

Figure A.11: Impulse responses under a positive 1% shock to formal technology for different values of κ.

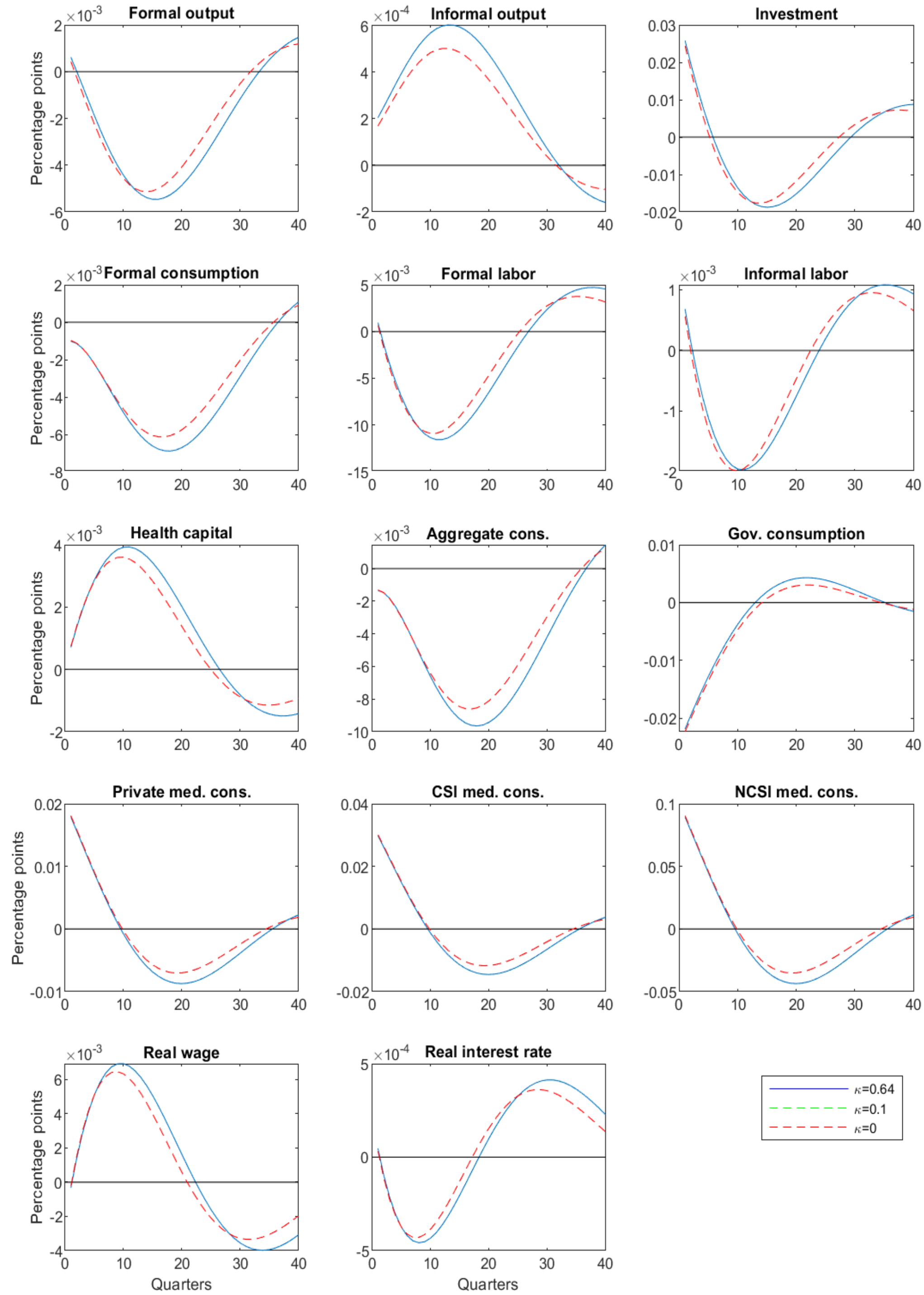

Figure A.12: Impulse responses under a positive 1% shock to health investment productivity for different values of κ.

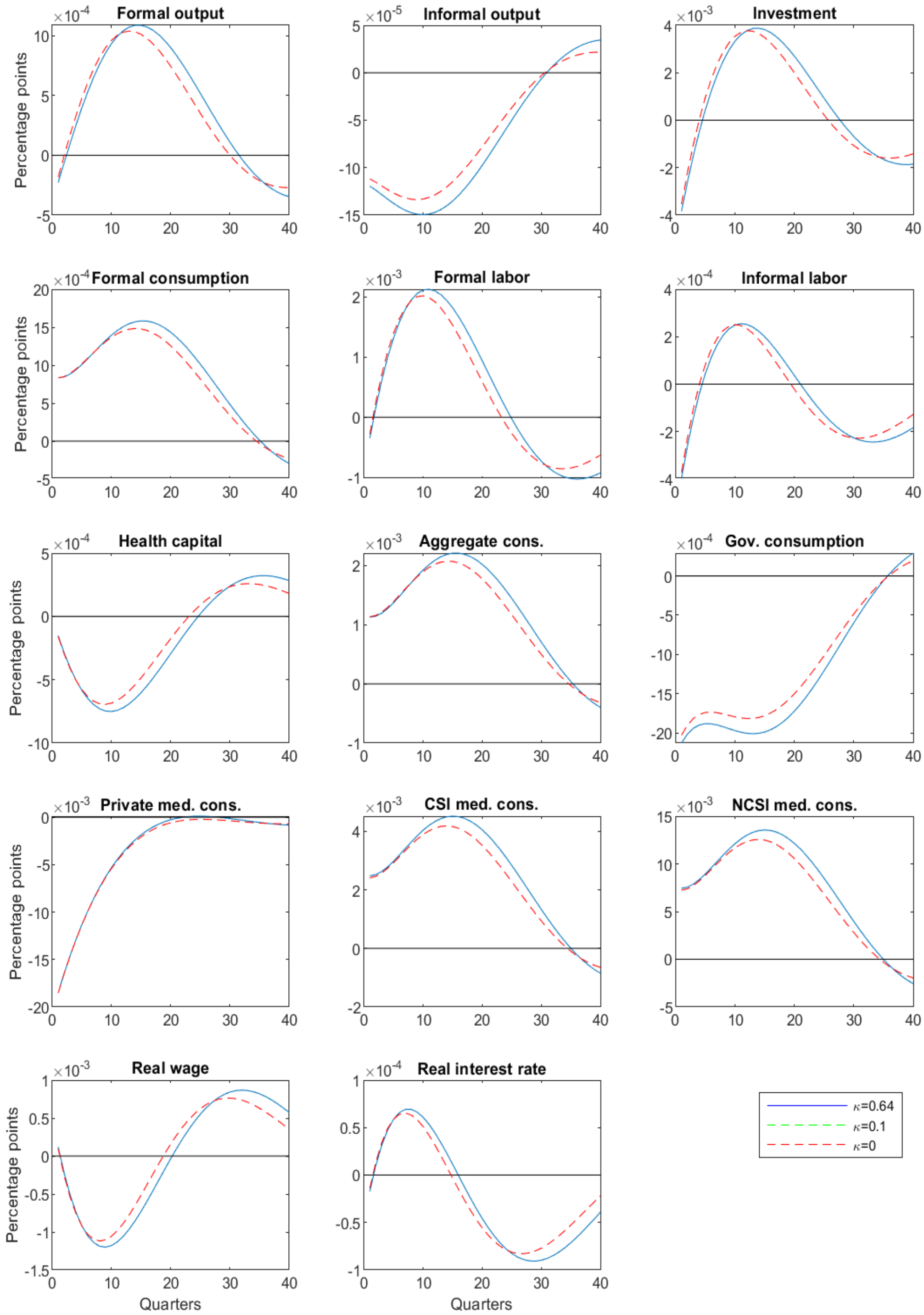

Figure A.13: Impulse responses under a positive 1% shock to private medical provider cost function for different values of κ.

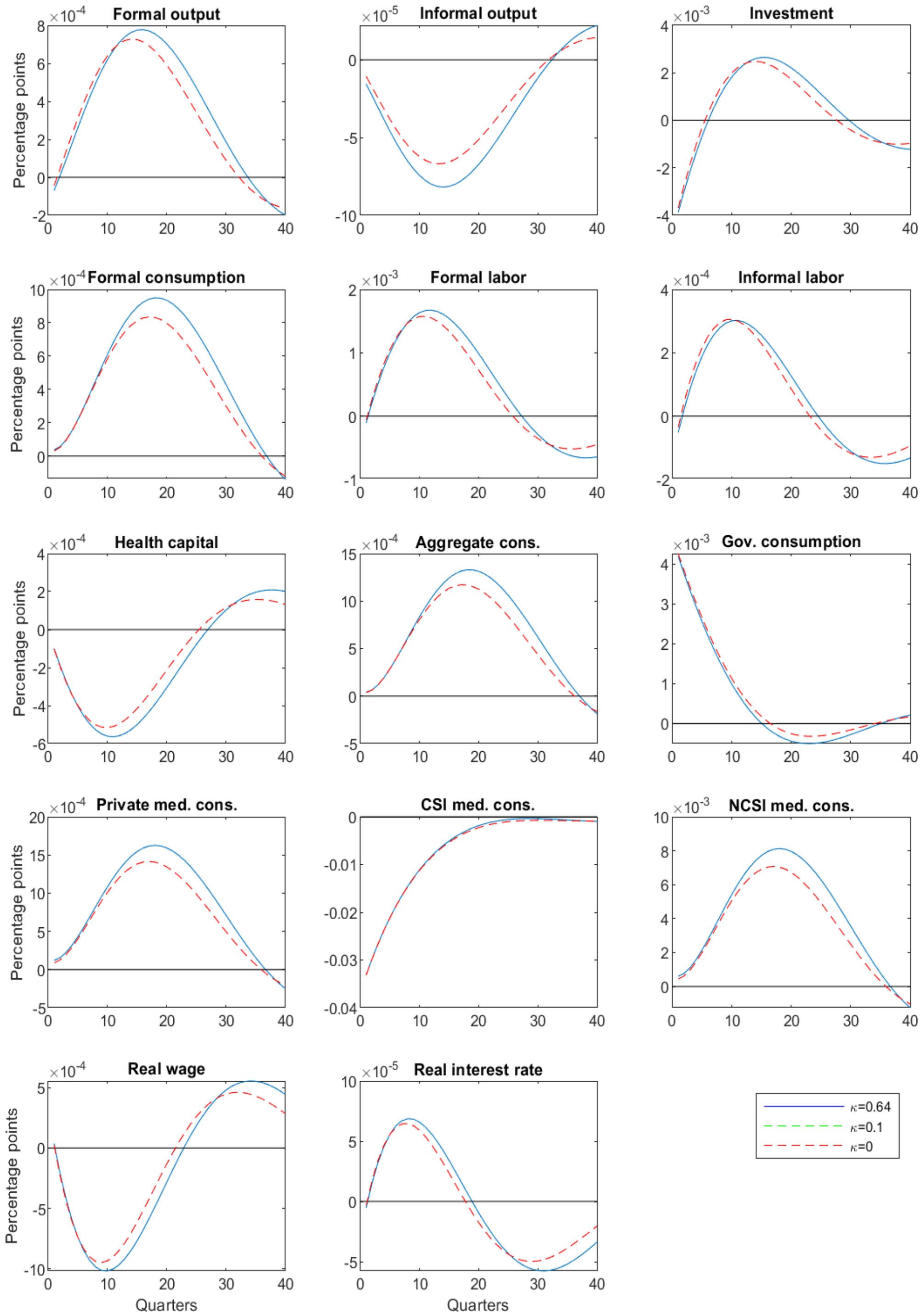

Figure A.14: Impulse responses under a positive 1% shock to CSI medical provider cost function for different values of κ.

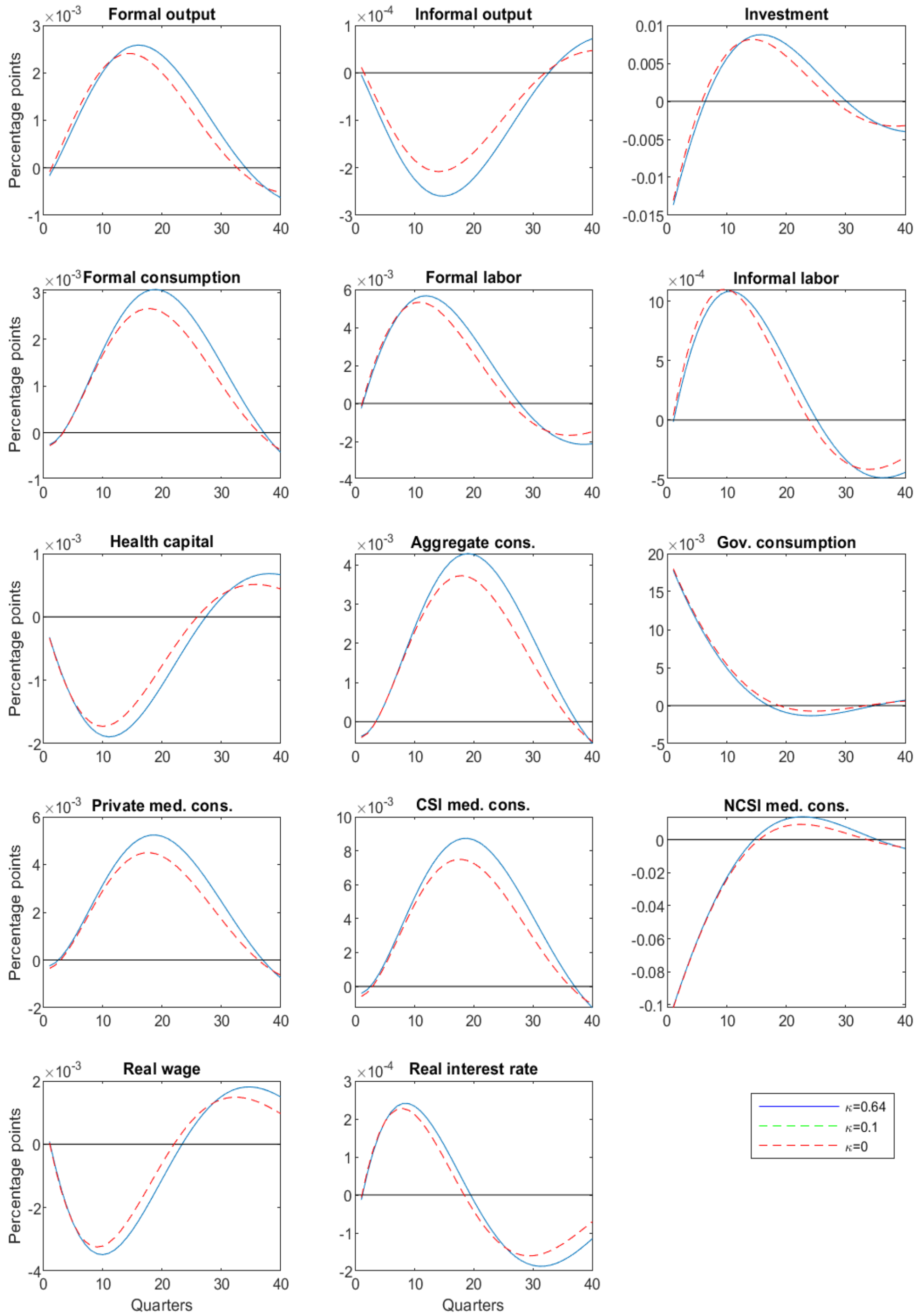

Figure A.15: Impulse responses under a positive 1% shock to NCSI medical provider cost function for different values of κ.

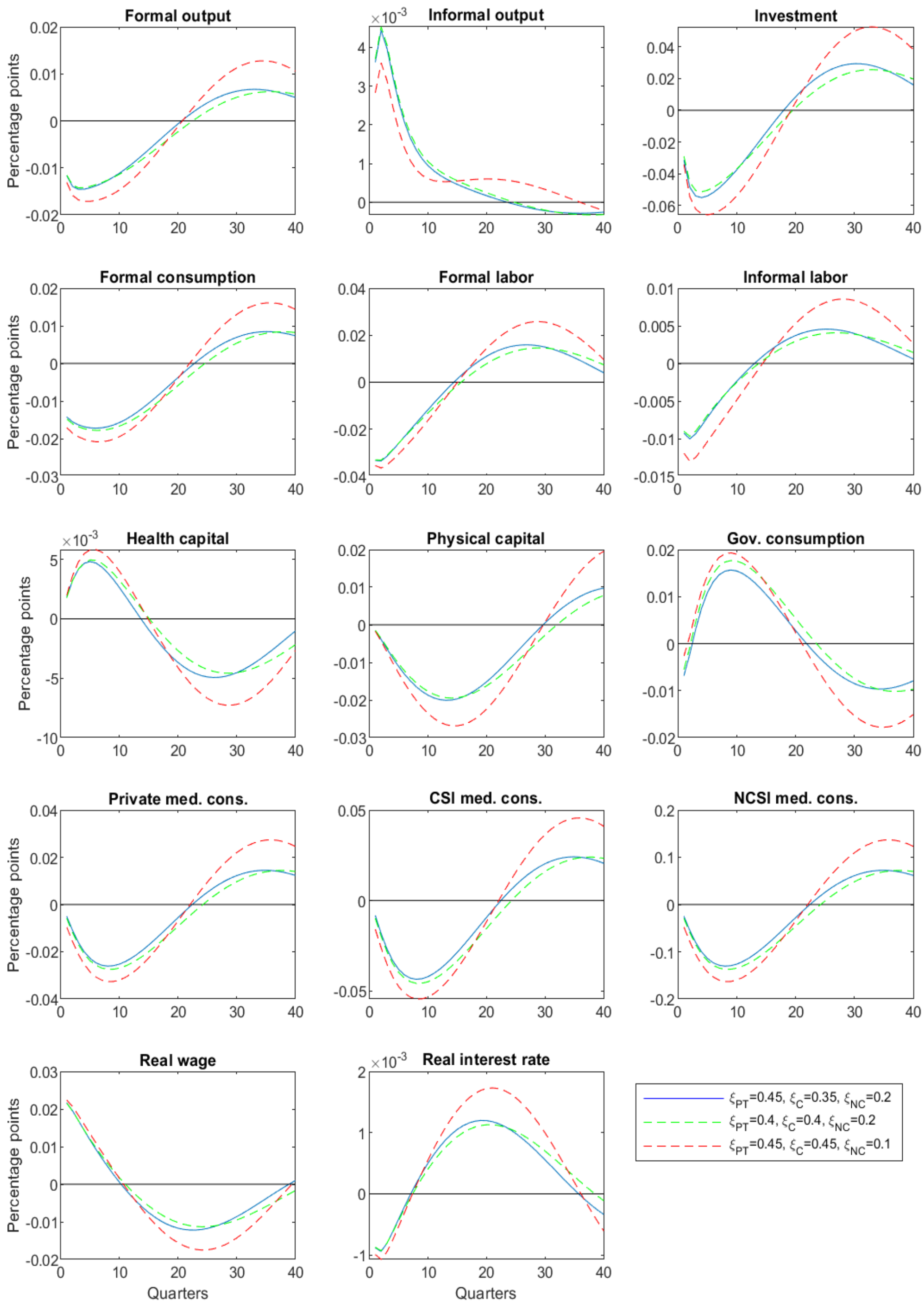

Figure A.16: Impulse responses under a positive 1% shock to formal technology for different values of ξ_{PT}, ξ_C, and ξ_{NC}.

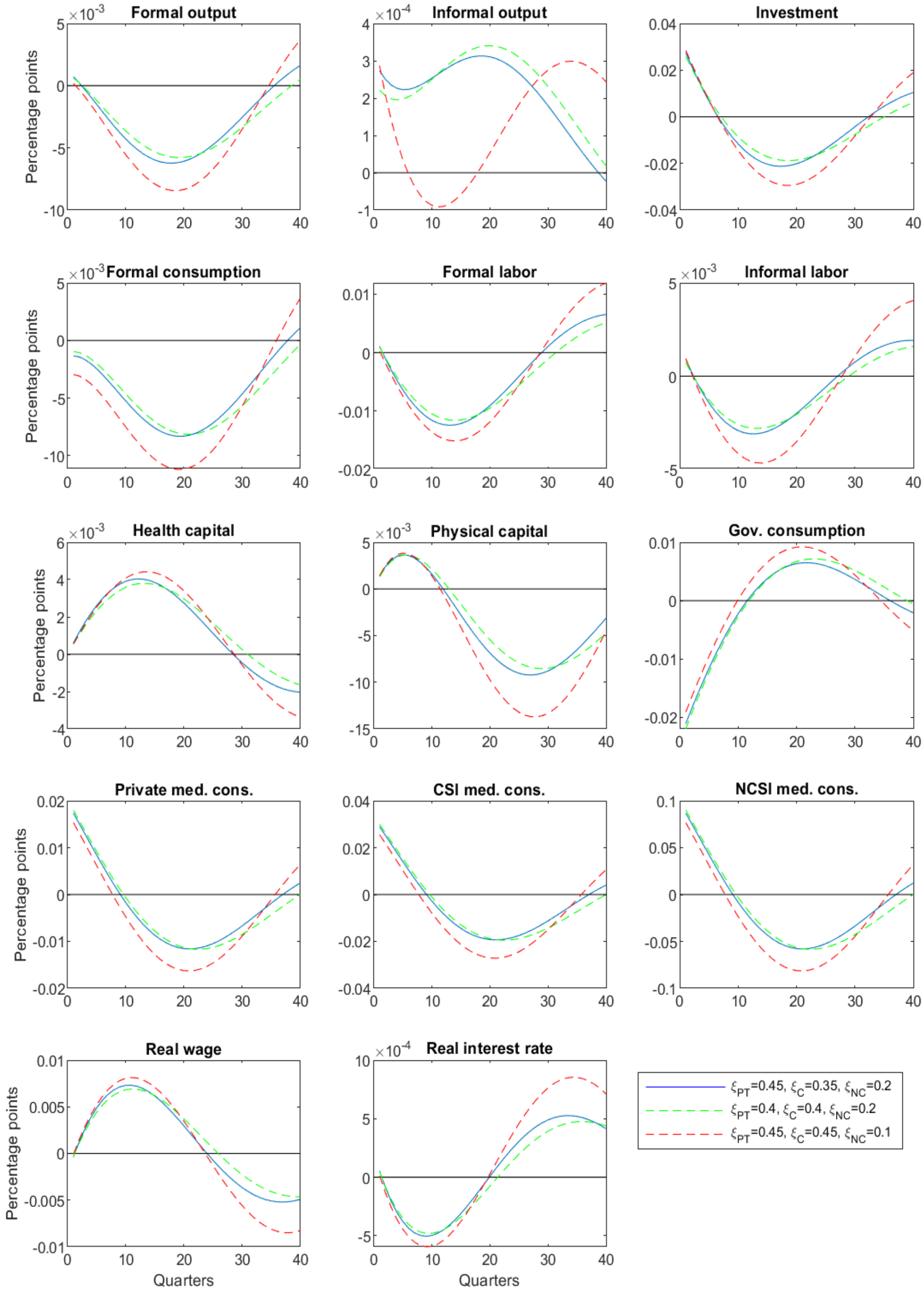

Figure A.17: Impulse responses under a positive 1% shock to health investment productivity for different values of ξ_{PT}, ξ_C, and ξ_{NC}.

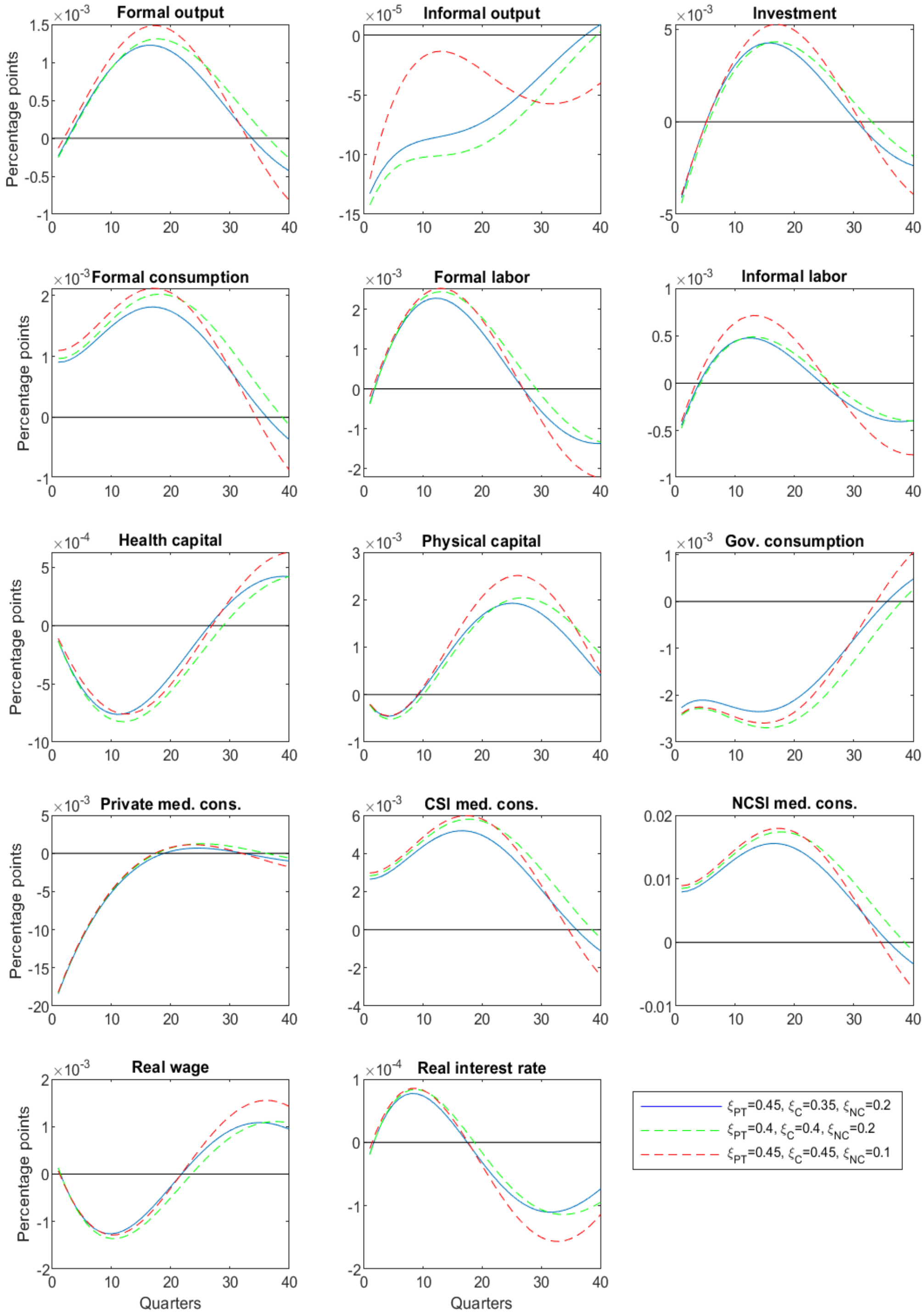

Figure A.18: Impulse responses under a positive 1% shock to private medical provider cost function for different values of ξ_{PT}, ξ_C, and ξ_{NC}.

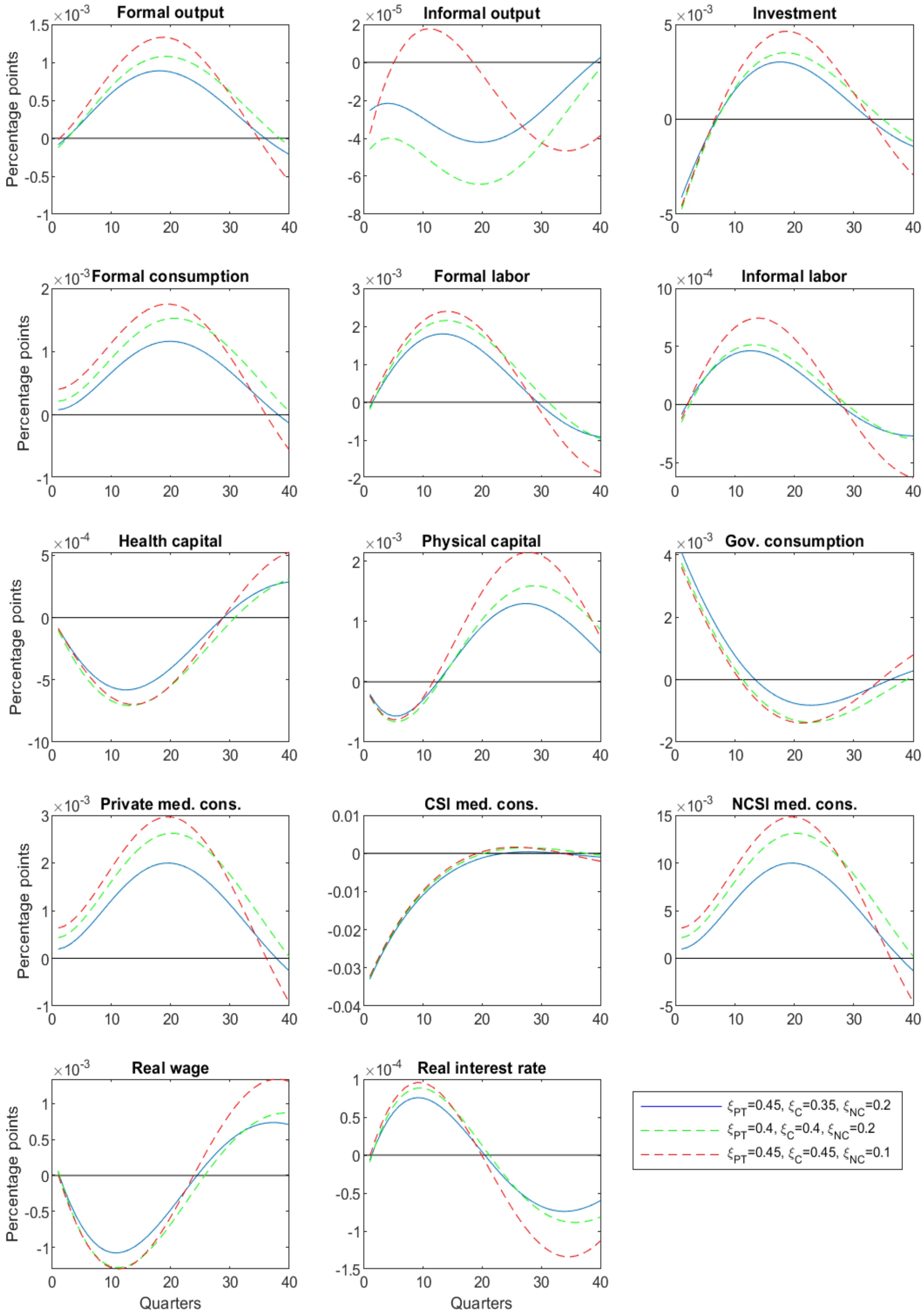

Figure A.19: Impulse responses under a positive 1% shock to CSI medical provider cost function for different values of ξ_{PT}, ξ_C, and ξ_{NC}.

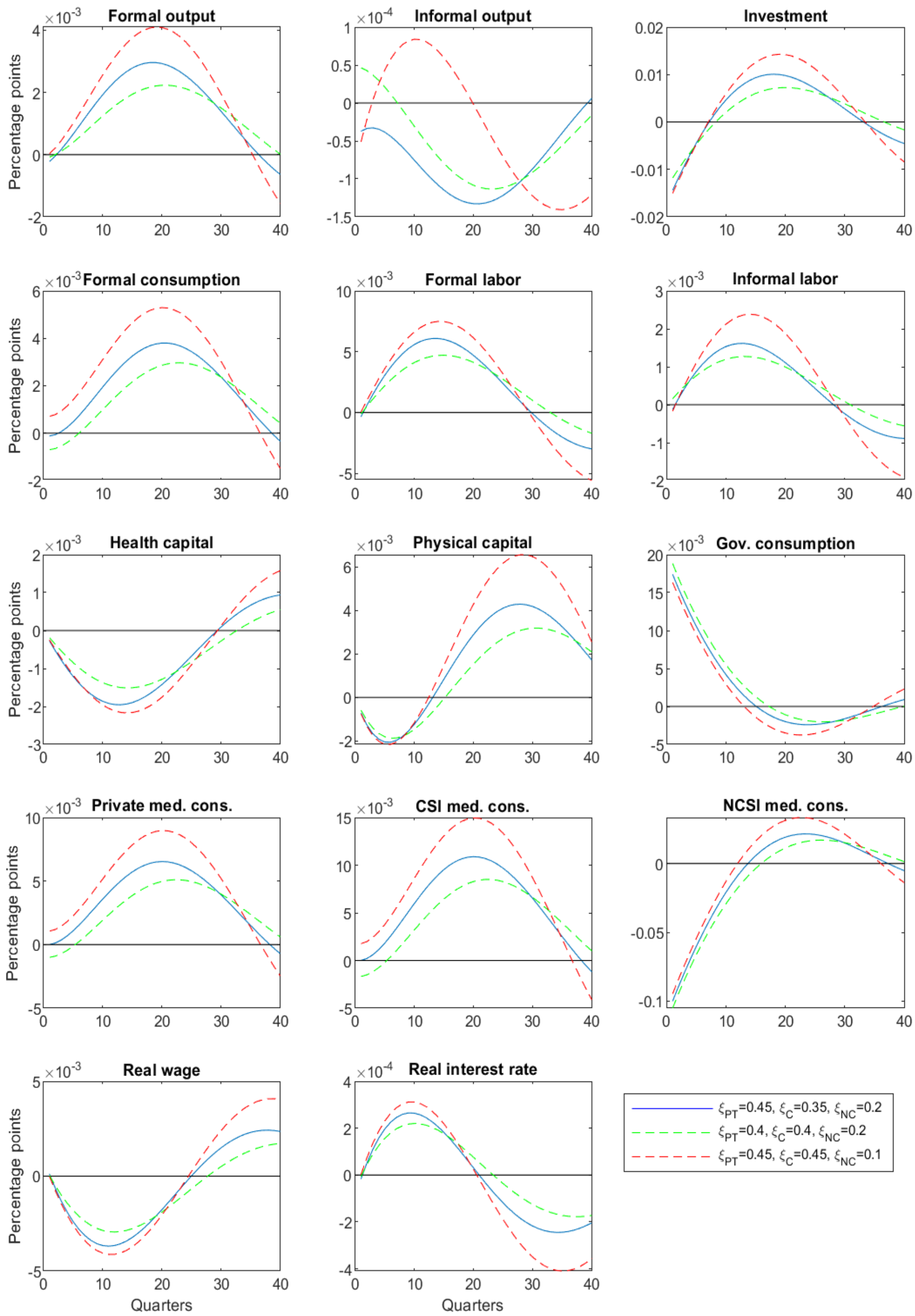

Figure A.20: Impulse responses under a positive 1% shock to NCSI medical provider cost function for different values of ξ_{PT}, ξ_C, and ξ_{NC}.

Appendix B

Independent productivity shocks between sectors

In this appendix, we present some results of the model where the productivity shocks to formal technology are not pass-through the informal sector. Here we analyze the transition dynamics for a 1% increase in the productivity of formal and informal goods. We then discuss the results in light of those obtained in the baseline model.

B.1 Transitional dynamics

B.1.1 Formal productivity shock

Figure B.1 presents the transitional dynamics of a 1% rise in formal productivity. That shock has an immediate and positive effect on both formal and informal output. Formal output increases on the impact, rising above its steady-state value as more output is produced for given production inputs. Subsequently, the positive deviation begins to decrease and turns negative after ten quarters. Just after 40 periods, the production level reaches its steady-state value again.

Formal consumption also instantaneously increases in relation to its steady-state value, but by a small proportion (almost 0.5%). Subsequently, the deviation continues to increase until it reaches a maximum (around period five) and gradually decreases thereafter.

Investment instantaneously increases by 6% due to the productivity shock (the shock increases the return to capital), but afterward, investment rapidly declines even below its steady-state value. Physical capital stock shows a bell-shaped impulse-response function in the first 20 periods. Initially, the increase in investment causes an increase in capital stock (net investment is positive). However, as investment decreases, the capital stock reaches a maximum, after which it begins to decrease.

Surprisingly, the formal labor reduces between 0.1 and 0.9 percentage points in the first 15 quarters after the shock (even when the wage has risen), and then gradually increases. The informal labor increases after the shock, but then it falls and follows a similar pattern as the formal work.

We can see that health expenditures rise considerably, which implies greater health capital accumulation. The private medical consumption and the CSI medical consumption increase nearly 1% in first the periods after the shock, and then they become negative for a long time. The same is true for the NCSI medical consumption, but in greater magnitude, since the initial increase is almost 4%.

Regarding production factor prices, there is an increase in wages as a result of the gains in productivity. The real interest rate initially undergoes a slight positive change, given the increase in the marginal productivity of capital, but later decreases below its steady-state value due to the process of capital accumulation.

Government spending rises immediately after the shock due to the increase in their earnings by both taxes (the shock has risen wages, real interest rate, and physical capital accumulation, some of the main components of government taxation). However, rapidly the government consumption becomes negative as the formal labor declines and the demand for public medical services increases.

One way to interpret these results is the following. When the formal productivity positive shock arises, formal output increases as inputs become more productive. Then it maintains above their steady-state level because of the greater investment in physical capital and health capital. However, people choose to substitute formal and informal labor for medical goods to exploit the gains of the productivity shock. Nevertheless, that kind of investment drives too many resources to something less productive than labor or physical capital. Consequently, output falls in the medium-run, reducing formal consumption, investment, and physical capital accumulation. Eventually, people realized that and started working again.

B.1.2 Informal productivity shock

Figure B.2 presents the transitional dynamics of a 1% rise in informal productivity. As we can see, the results are very different from the formal productivity shock. The level of informal output increases on the impact rising above its steady-state value as more output is produced for given production inputs. Subsequently, the positive deviation begins to decrease but shows significant persistence over time. After 20 quarters, the informal production level reaches its steady-state value again. Remember that informal consumption equals informal output, so the same is true for this kind of consumption.

In clear contrast with the formal productivity shock case, both non-medical production types follow opposite trajectories. The formal output decreases more than 2% immediately after the shock and takes almost 20 quarters to reach their pre-shock level. Similarly, formal consumption also instantaneously decreases in relation to its steady-state value by 2% and gradually decreases after that. Investment instantaneously decreases by 1% as a result of the

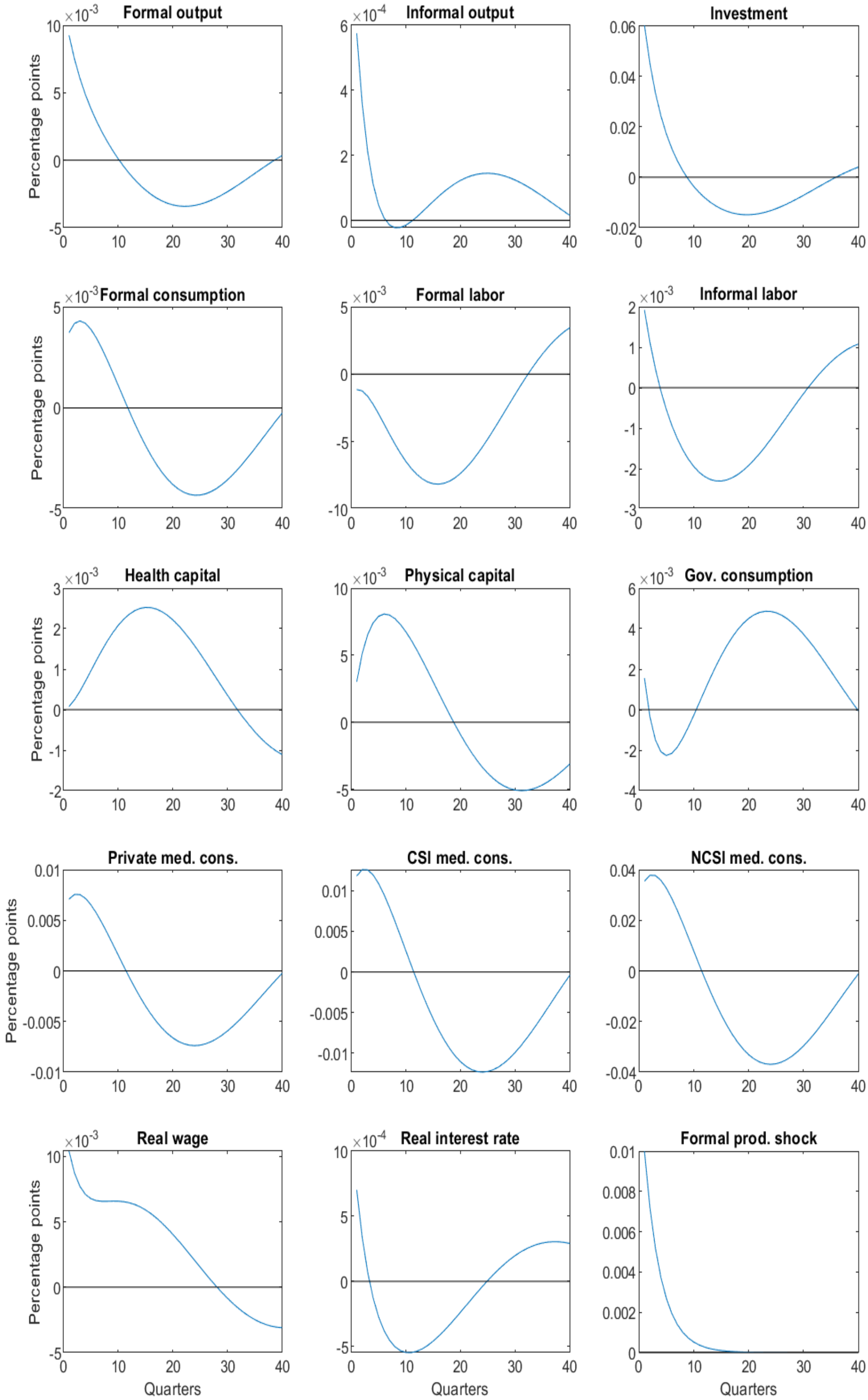

Figure B.1: Impulse responses under a positive 1% shock to formal technology without pass-through of technology shocks between sectors.

productivity shock (the shock reduces the return to capital because it is not an input of informal production). Physical capital also decreases gradually after the shock as investment reduces.

Here, both forms of labor decrease initially, but formal work is reduced to a greater extent. After ten quarters, both types of work return to their steady-state values and slightly increases after that.

The three types of medical consumption decrease immediately after the shock, but with difference in the magnitudes between them. The CSI medical consumption reaches a minimum (near 5% below the steady-state level) five quarters after the shock, then increases gradually until it reaches its pre-shock level 20 quarters ahead. The private and the NCSI medical spending follows a similar pattern but to a lesser extent.

In this case, initially, we see a health capital accumulation above their steady-state level. This effect is not a direct consequence of more medical spending, as in the first case analyzed, but a result of fewer working hours in both sectors.

Regarding production factor prices, there is an increase in wages due to the gains in productivity by the health capital. The real interest rate initially undergoes a slight negative change, given the decrease in the marginal productivity of capital, but later increases above its steady-state value as a result of the process of capital shrinkage.

Government spending also follows an opposite trajectory concerning the formal productivity shock. Immediately, with the decrease in real interest rate, physical capital accumulation, and formal labor, the government income reduces, and government consumption does the same. Thereafter, as public medical services demand reduces, the share of public spending invested in that sector lowers, and eventually, the government consumption turns positive.

B.2 Discussion

As the impulse-response analysis shows, this model presents some undesirable properties: formal labor decreases in response to a formal productivity shock, and there is a little reallocation effect to the informal sector in this situation.

In the Fernández and Meza (2015) model, the reallocation of labor to the formal sector in the face of a productivity shock in that sector is mainly due to the incomplete pass-through of the shock to the informal sector. In their model, when the shock occurs, both types of work increase, but because of the incomplete pass-through, eventually more and more people decide to work in the formality because relative competitiveness increases in this sector, which generates the reassignment of the labor force between sectors. Given that the shocks are not correlated in our model, we would expect that the formal productivity shock only affects this sector in the first instance, generating a more significant reallocation between sectors. However, this does not happen.

In this case, spending on medical services encompasses a considerable part of the benefits of

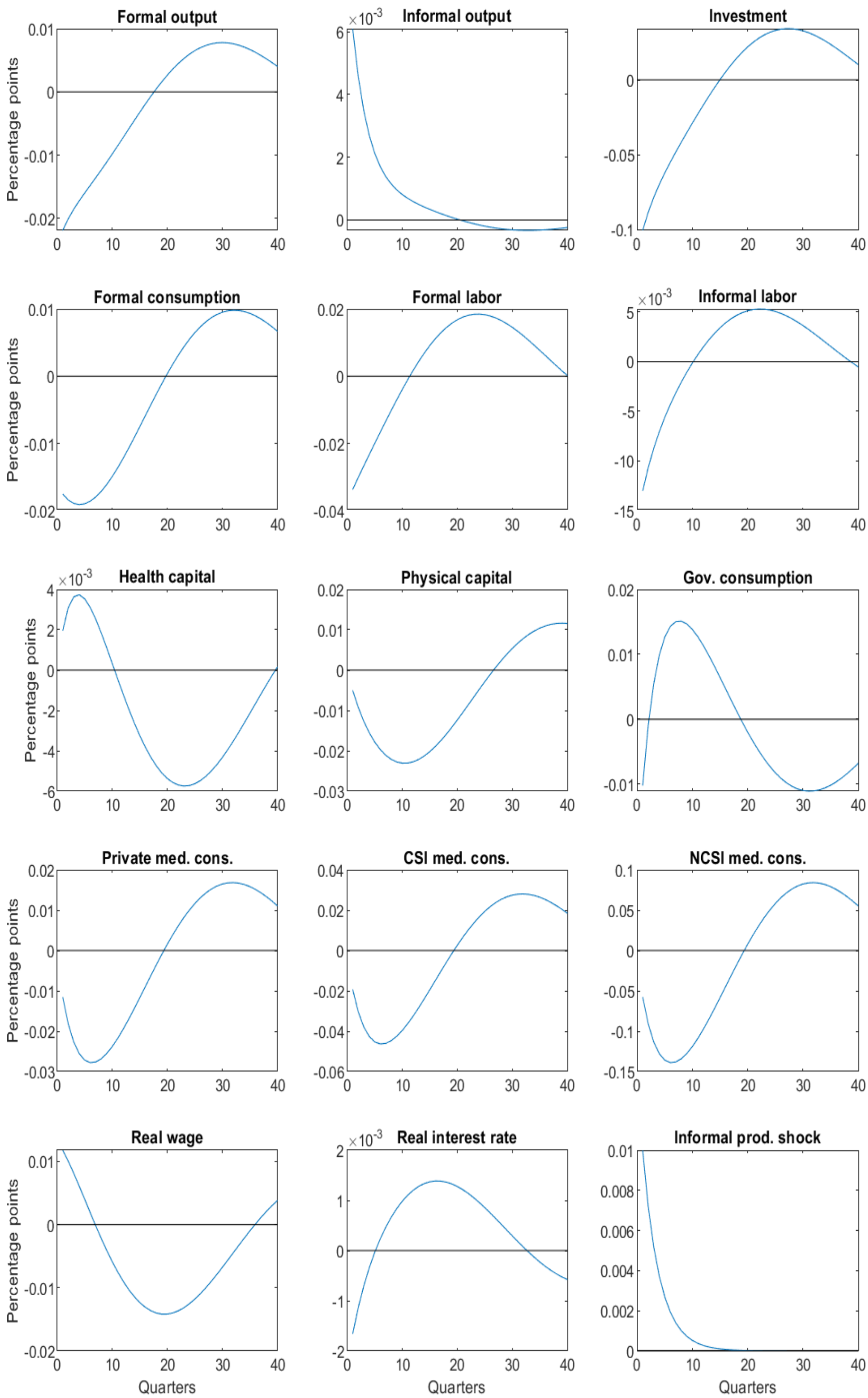

Figure B.2: Impulse responses under a positive 1% shock to informal technology without pass-through of technology shocks between sectors.

the productivity shock since, through this investment in health capital, individuals can increase both types of production. This effect is reinforced by reducing working hours, as this also contributes to having a higher health capital in the following periods. This combined effect seems to explain the fall in formal employment.

However, it is essential to remark that this model can replicate the expected reallocation effect from the formal to the informal sector following a productivity shock in the last sector, but only when we consider higher γ_n values.

On the other hand, this model does a reasonably good job of replicating the increase in medical expenses (especially with higher levels of γ_n), both in public and private sectors, due to a productivity shock (in the formal sector of the economy), as documented by Kelly (2017) for the case of the US. In fact, except for the impact on the labor market previously discussed, the effects on the other relevant variables of the model (such as accumulation of physical capital, wages, and accumulation of health capital) are consistent with those presented by Kelly (2017).

Concerning the medical spending following an informal productivity shock, we saw in Figure B.2 that our model predicts that an initial increase in the informal sector is associated with an initial increase in medical spending, but the latter turns negative rapidly. The increase in informality leads to a greater depreciation of capital in health, but this is initially offset by reducing capital depreciation due to the reduction of formal work. Such a drop in formal work counteracts even the reduction in medical expenses initially, but the health capital stock also ends up falling after some time.

References

Aguiar, M., & Gopinath, G. (2004). *Emerging Market Business Cycles: the Cycle is the Trend* (Working Paper No. 10734). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w10734

Aguiar, M., & Gopinath, G. (2007, feb). Emerging Market Business Cycles: The Cycle Is the Trend. *Journal of Political Economy*, *115*(1), 69–102. Retrieved from https://www.journals.uchicago.edu/doi/10.1086/511283 doi: 10.1086/511283

Antón, A., Hernández, F., & Levy, S. (2012). *The End of Informality in Mexico? Fiscal Reform for Universal Social Insurance*. Washington, DC: Inter-American Development Bank. Retrieved from https://publications.iadb.org/es/publicacion/10827/end-informality-mexico-fiscal-reform-universal-social-insurance

Arredondo, A., Damían, T., & De Icaza, E. (1995). Una aproximación al estudio de costos de servicios de salud en México. *Salud pública de México*, *37*(5), 437–445. Retrieved from https://www.redalyc.org/articulo.oa?id=10637510

Bayraktar-Sağlam, B. (2017). *Private Health Care Versus Public Health Care: Complements or Substitutes* (Working Paper). Paris: The Paris Center for Law and Economic (CRED). Retrieved from https://pet2017paris2.sciencesconf.org/142000

Cutler, D., Deaton, A., & Lleras-Muney, A. (2006, may). The Determinants of Mortality. *Journal of Economic Perspectives*, *20*(3), 97–120. Retrieved from https://pubs.aeaweb.org/doi/10.1257/jep.20.3.97 doi: 10.1257/jep.20.3.97

Dalgaard, C.-J., & Strulik, H. (2014, jun). OPTIMAL AGING AND DEATH: UNDERSTANDING THE PRESTON CURVE. *Journal of the European Economic Association*, *12*(3), 672–701. Retrieved from https://academic.oup.com/jeea/article-lookup/doi/10.1111/jeea.12071 doi: 10.1111/jeea.12071

Fernández, A., & Meza, F. (2015, apr). Informal employment and business cycles in emerging economies: The case of Mexico. *Review of Economic Dynamics*, *18*(2), 381–405. Retrieved from https://linkinghub.elsevier.com/retrieve/pii/S1094202514000416 doi: 10.1016/j.red.2014.07.001

Finkelstein, A., Luttmer, E. F. P., & Notowidigdo, M. J. (2013, jan). What Good is Wealth Without Health? The Effect of Health on the Marginal Utility of Consumption. *Journal of the European Economic Association*, *11*(SUPPL. 1), 221–258. Retrieved from https://academic.oup.com/jeea/article-lookup/doi/10.1111/j.1542-4774.2012.01101.x doi: 10.1111/j.1542-4774.2012.01101.x

Grossman, M. (1972, mar). On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy*, *80*(2), 223–255. Retrieved from https://www.journals.uchicago.edu/doi/10.1086/259880 doi: 10.1086/259880

Hall, R. E., & Jones, C. I. (2007, feb). The Value of Life and the Rise in Health Spending. *The Quarterly Journal of Economics*, *122*(1), 39–72. Retrieved from https://academic.oup.com/qje/article-lookup/doi/10.1162/qjec.122.1.39 doi: 10.1162/qjec.122.1.39

He, H., Huang, K. X. D., & Hung, S.-T. (2014). Are Recessions Good for Your Health? When Ruhm Meets GHH. *Dynare Working Papers*(31). Retrieved from https://www.dynare.org/wp-repo/dynarewp031.pdf

He, H., Huang, K. X. D., & Hung, S.-T. (2016). *Real business cycle with endogenous health* (Working Paper). Vanderbilt University Department of Economics Working Paper Series. Retrieved from http://www.accessecon.com/Pubs/VUECON/VUECON-16-00012.pdf

Horvath, J. (2018, mar). Business cycles, informal economy, and interest rates in emerging countries. *Journal of Macroeconomics*, *55*, 96–116. Retrieved from https://linkinghub.elsevier.com/retrieve/pii/S0164070416301707 doi: 10.1016/j.jmacro.2017.10.002

Huang, K., & Huffman, G. W. (2014, oct). UNEMPLOYMENT AND WELFARE IMPLICATIONS OF THE CURRENT U.S. TAX TREATMENT OF EMPLOYER-PROVIDED MEDICAL INSURANCE. *Macroeconomic Dynamics*, *18*(7), 1547–1580. Retrieved from https://www.cambridge.org/core/product/identifier/S1365100513000023/type/journal{_}article doi: 10.1017/S1365100513000023

Instituto Mexicano para la Competitividad. (2018). *Pequeños pasos para transformar al sistema de salud*. Retrieved from https://imco.org.mx/pequenos-pasos-transformar-al-sistema-salud/{#}{_}ftnref1

Kelly, M. (2017, jun). Health capital accumulation, health insurance, and aggregate outcomes: A neoclassical approach. *Journal of Macroeconomics*, *52*, 1–22. doi: 10.1016/j.jmacro.2017.02.003

Kelly, M. (2020, mar). Medicare for all or medicare for none? A macroeconomic analysis of healthcare reform. *Journal of Macroeconomics*, *63*, 103170. doi: 10.1016/j.jmacro.2019.103170

Levy, S., & Schady, N. (2013, feb). Latin America's Social Policy Challenge: Education, Social Insurance, Redistribution. *Journal of Economic Perspectives*, *27*(2), 193–218. Retrieved from https://pubs.aeaweb.org/doi/10.1257/jep.27.2.193 doi: 10.1257/jep.27.2.193

Leyva, G., & Urrutia, C. (2020, sep). Informality, labor regulation, and the business cycle. *Journal of International Economics*, *126*, 103340. doi: 10.1016/j.jinteco.2020.103340

Medina, L., & Schneider, F. (2018). Shadow Economies Around the World: What Did We Learn Over the Last 20 Years? *IMF Working Papers*, *18*(17), 1. Retrieved from https://elibrary.imf.org/view/journals/001/2018/017/001.2018.issue-017-en.xml doi: 10.5089/9781484338636.001

Picone, G., Uribe, M., & Mark Wilson, R. (1998, apr). The effect of uncertainty on the demand for medical care, health capital and wealth. *Journal of Health Economics*, *17*(2), 171–185. Retrieved from https://linkinghub.elsevier.com/retrieve/pii/S0167629697000283 doi: 10.1016/S0167-6296(97)00028-3

Restrepo-Echavarria, P. (2014, aug). Macroeconomic volatility: The role of the informal economy. *European Economic Review*, *70*, 454–469. Retrieved from https://linkinghub.elsevier.com/retrieve/pii/S0014292114000993 doi: 10.1016/j.euroecorev.2014.06.012

Ruhm, C. J. (2000, may). Are Recessions Good for Your Health? *The Quarterly Journal of Economics*, *115*(2), 617–650. Retrieved from https://academic.oup.com/qje/article-lookup/doi/10.1162/003355300554872 doi: 10.1162/003355300554872

WHO. (2019). *Global Monitoring Report on Financial Protection in Health 2019* (Tech. Rep.). World Health Organization, The World Bank. Retrieved from https://www.who.int/publications/i/item/global-monitoring-report-on-financial-protection-in-health-2019