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COVID-19: Economic Consequences for a Small Tourism Dependent Economy

COVID-19: Consequências econômicas para uma pequena economia dependente do turismo

COVID-19: Consecuencias económicas para una pequeña economía dependiente del turismo

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Keywords:

Two sector open economy model;
Sectoral search unemployment;
Tourism demand;
COVID-19 shock.

Abstract

This paper analyzes the economic impact of the COVID-19 pandemic on a small tourism dependent open economy. The lockdown affected both the demand side and the supply side of the economy, as production of goods and services dramatically dropped due to firms' shutdowns, broken supply chains, or bankruptcies, and aggregate demand diminished due to lower consumer confidence and investment cutbacks, accompanied by a dramatic fall in international tourism demand, in particular due to travel restrictions. We look on these supply and demand changes through the lens of a macroeconomic model of a small open economy, comprising an industrial and a tourism sector. For this purpose, we modify Schubert's (2013) model by introducing a multiple shock which reflects (i) reduced sectoral productivities due to, e.g., broken supply chains, (ii) a drop in employment due to firms' lockdowns, and (iii) a sharp decline in international tourism demand. We find that the multiple shock leads to an immediate drop in GDP and a boost of the short-run unemployment rate, followed by a gradual transition back to steady state. The adverse effects on the tourism sector are the more severe the slower international tourism demand reverts to pre-crisis levels, but they do not strongly spill over to the industrial sector. Furthermore, even if international tourism demand recovers quickly, the effects on the industrial sector barely change. The length of the industrial sector's recovery basically depends on the speed of restoring its sectoral productivity rather than on international tourism demand. The reason for this result can be found in the absorbing effect of the relative price of tourism services in terms of the industrial good.

Palavras-chave:

Modelo de economia aberta de dois setores;
Desemprego setorial de pesquisa;
Demanda turística;
Choque COVID-19.

Resumo

Este artigo analisa o impacto econômico da pandemia de COVID-19 em uma pequena economia aberta e dependente do turismo. O lockdown afetou tanto o lado da demanda, quanto o lado da oferta da economia, uma vez que a produção de bens e serviços caiu drasticamente devido a fechamentos de empresas, cadeias de abastecimento interrompidas ou falências. A demanda agregada diminuiu devido à menor confiança do consumidor e cortes de investimentos, acompanhados por uma queda dramática na demanda de turismo internacional, em particular devido a restrições de viagens. Vemos essas mudanças na oferta e

na demanda pelas lentes de um modelo macroeconômico de uma pequena economia aberta que compreende um setor industrial e um de turismo. Para este efeito, modificamos o modelo de Schubert (2013), introduzindo um choque múltiplo que reflete (i) produtividade setorial reduzida devido a, por exemplo, cadeias de abastecimento interrompidas, (ii) uma queda no emprego devido ao fechamento de empresas, e (iii) um declínio acentuado na demanda de turismo internacional. Descobrimos que o choque múltiplo leva a uma queda imediata do PIB e um aumento da taxa de desemprego de curto prazo, seguido por uma transição gradual de volta ao estado estacionário. Os efeitos adversos sobre o setor de turismo são tanto mais graves quanto mais lenta for o retorno da demanda turística internacional aos níveis anteriores à crise. Contudo, os efeitos sobre o turismo não afetam fortemente o setor industrial. Além disso, mesmo que a demanda turística internacional se recupere rapidamente, os efeitos sobre o setor industrial praticamente não mudam. A duração da recuperação do setor industrial depende basicamente da velocidade de restauração de sua produtividade setorial, e não da demanda turística internacional. A razão para esse resultado pode ser encontrada no poder de absorção do preço relativo dos serviços turísticos em termos do bem industrial.

Palabras clave:

Modelo de economía abierta de dos sectores;
Desempleo de investigación;
Demanda turística;
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Resumen

Este artículo analiza el impacto económico de la pandemia de COVID-19 en una economía pequeña, abierta y dependiente del turismo. El lockdown afectó tanto al lado de la demanda, como al de la oferta de la economía, ya que la producción de bienes y servicios cayó drásticamente debido al cierre de empresas, cadenas de suministro interrumpidas o quiebras. La demanda agregada ha disminuido debido a la menor confianza del consumidor y los recortes de la inversión, acompañada de una caída dramática en la demanda turística internacional, en particular debido a las restricciones de viaje. Vemos estos cambios en la oferta y la demanda a través de la lente de un modelo macroeconómico de una pequeña economía abierta que comprende un sector industrial y uno turístico. Para ello, modificamos el modelo de Schubert (2013), introduciendo un shock múltiple que refleja (i) la reducción de la productividad del sector debido, por ejemplo, a cadenas de suministro interrumpidas, (ii) una caída del empleo por cierre de empresas, y (iii) una fuerte caída de la demanda de turismo internacional. Descubrimos que el choque múltiple conduce a una caída inmediata del PIB y un aumento de la tasa de desempleo a corto plazo, seguido de una transición gradual de regreso al estado estacionario. Los efectos adversos sobre el sector turístico son tanto más graves cuanto más lento es el retorno de la demanda turística internacional a los niveles anteriores a la crisis. Sin embargo, los efectos sobre el turismo no afectan fuertemente al sector industrial. Además, incluso si la demanda turística internacional se recupera rápidamente, los efectos sobre el sector industrial cambian poco. La duración de la recuperación del sector industrial depende básicamente de la velocidad de recuperación de su productividad sectorial, y no de la demanda turística internacional. La razón de este resultado se puede encontrar en el poder de absorción del precio relativo de los servicios turísticos en términos de bienes industriales.

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1 INTRODUCTION

At the end of 2019, the SARS-CoV-2 virus (COVID-19) was discovered in Wuhan, China, where it spread off over the world. On 11 March 2020, the World Health Organization assessed COVID-19 as a pandemic. The COVID-19 pandemic caused a huge shock to the entire world, as it hit almost every country and its economy. Of course, the economy is continuously hit by shocks, but the nature of the COVID shock is quite unique: "The COVID-19 pandemic differs markedly from past triggers of downturns. Infections reduce labor supply. Quarantines, regional lockdowns, and social distancing — which are essential to contain the virus [...] — curtail mobility, with particularly acute effects on sectors that rely on social interactions (such as travel, hospitality, entertainment, and tourism). Workplace closures disrupt supply chains and lower productivity. Layoffs, income declines, fear of contagion, and heightened uncertainty make people spend less, triggering further business closures and job losses. There is a de facto shutdown of a significant portion of the economy. [...] These domestic disruptions spill over to trading partners through trade and global value chain linkages, adding to the overall macroeconomic effects." (IMF, 2020, p. 2). "Current projections suggest that the COVID-19 global recession will be the deepest since the end of World War II, with the largest fraction of economies experiencing declines in per capita output since 1870. Output of emerging market and developing economies is expected to contract in 2020 for the first time in at least 60 years. The uncertain course of the pandemic,

in the absence thus far of effective vaccines or treatments, has caused extraordinary economic uncertainty" (World Bank, 2020, p. 13).

The COVID pandemic caused unemployment to soar. The International Labour Organization estimates that working-hour losses for the second quarter of 2020 relative to the last quarter of 2019 reach 14.0% worldwide (equivalent to 400 million full-time jobs), with the largest reduction (18.3 %) occurring in the Americas (ILO, 2020, p. 1). In a lot of countries, the current account deteriorated (see World Bank, 2020, p. 23), and sovereign borrowing costs (interest rates) increased in emerging market and developing economies (see World Bank (2020, pp. 43 – 44).

In Europe, COVID led to huge drops in GDP: 15% in the Euro zone, 14.4% in the European Union, 22.1% in Spain, 17.3% in Italy, 19% in France (percentage change of GDP in the second quarter 2020 compared with the same quarter of the previous year, see Eurostat (2020). In Latin America, the projected GDP decline amounts to 9.1%, caused by strong reductions in industrial production between 15 and 30% (ECLAC, 2020).

Among the economy's sectors, the tourism sector has been hit particularly, as in the first four months of 2020 tourism tumbled 44% globally (see ECLAC (2020). "The COVID-19 pandemic has caused an unprecedented disruption to travel and tourism, bringing world destinations and outbound markets to a standstill." (UNWTO, 2020b, p. 3).

In many countries the tourism sector substantially contributes to GDP with a share of 10% and more. There is the common view that "tourism is one of the most prominent and powerful economic and social sectors [...]; tourism is among the world's most important exporting sectors; and tourism is labor rather than capital intensive [...]" (see Costa, 2012), suggesting that shocks hitting the tourism industry will have severe effects on the whole economy and on labor markets.

The aim of this paper is to investigate how the COVID-19 pandemic affected and affects an open economy which depends on international tourist arrivals. What are the economic impact effects of the pandemic? What economic dynamics the COVID shock initiates? Will the economy recover quickly or slowly? What is the role of tourism during transition? To address these important questions, we modify the dynamic two sector model of a small open economy developed by Schubert (2013), which is based on the standard two sector open economy model (for a detailed description (see Turnovsky, 1997, ch. 4). The model economy produces an internationally traded homogeneous industrial good, and tourism services, which can be distinguished from tourism services produced in other countries. We will model this feature by means of a demand function of foreigners for domestic tourism services, which depends on the relative price of tourism (see Schubert; Brida, 2009).

As the model comprises only two sectors, these have to be broadly defined. In particular, "tourism services" are not only consumed by foreigners, but also by domestic residents, and include also "indirect" types of services, e.g., expenditures in restaurants. Domestic residents' tourism demand abroad is included in their demand for the industrial good. The economy can borrow on the international financial market, but faces a country specific risk premium which depends on the debt-GDP ratio. Expenditures are thus not constrained period by period by production and earnings from tourism.[1] However, an intertemporal budget constraint has to be met.

One important feature of the model concerns labor markets. The economy is characterized by two separated labor markets, one for each sector, in which search unemployment a là Mortensen and Pissarides[2] arises. Workers realistically cannot instantaneously move between sectors because, e.g., the two sectors require different skills. Such movements are only possible over time. As our focus is more on the short and intermediate run and to keep the model parsimonious, we abstract from physical capital accumulation.[3]

[1] Models in which expenditures are completely financed by tourism earnings can be found in, e.g., Hazari and Sgro (2004, ch. 12), and Nowak, Sahli, and Cortés-Jiménez (2007).

[2] See Pissarides (2000) for an overview.

[3] Schubert (2011) shows that the unemployment dynamics are quite independent from capital accumulation, and Cogley and Nason (1995) show that the response of the capital stock to productivity shocks has little influence on the overall dynamics. In dynamic monetary macroeconomic models, it is common to ignore the capital stock and its role, see e.g., Walsh (2010).

Reflecting recent experience, the COVID-shock is modelled both on the supply and the demand side. On the supply side, labor is negatively affected due to infections and firms' lockdown, and broken supply chains reduce total factor productivity, both leading to lower sectoral production. On the demand side, we focus on the sharp reduction in international tourist arrivals. We investigate a multiple shock, which is a combination of (i) an exogenous drop in sectoral employments, (ii) reductions in sectoral total factor productivities, and (iii) international tourism demand, modelled by an exogenous demand shift. While the dynamics on the labor markets are driven by search (unemployment) and matching searching workers with open positions (job offers posted by firms), we assume that sectoral productivities and the international tourism demand shift parameter gradually recover and will eventually return to their pre-shock levels.

Because the model's dynamics cannot be analyzed analytically due to the model's complexity, we run numerical simulations, based on a plausible calibration, where we differentiate between two scenarios. In line with the empirical evidence stressed above, we find that the COVID-19 shock results immediately in a sharp decline in GDP and a boost in unemployment rates, and an increase in the interest rate. Production and employment in the industrial sector recover faster than in the tourism sector, due to the only slowly recovery of international tourism demand (the Iata, 2020) estimates that it will take five years to return to pre-pandemic levels of air passenger demand, which can serve as a proxy for foreigners' tourism demand, see UNWTO, 2020b, p. 4). The economy's industrial sector will fully recover after roughly two years, whereas the tourism sector will need approximately ten years to reach its pre-shock status. The country's external debt and the debt-GDP ratio sharply increase during transition. And as the demand drop for domestically produced tourism services outweigh the reduction in domestic tourism service production by far, the price of tourism services falls on impact and follows a non-monotone path back to its pre-shock level. Due to these price movements, domestic residents will change their consumption pattern. They will reduce their consumption of foreign tourism services ("holidays abroad") and increase their consumption of domestically supplied tourism services ("holidays at home"), which may have important consequences for destination management. Finally, our theoretical findings suggest that the way back to normality is a long one, and that sectors do not recover at the same speed: the industrial sector will recover much faster than the domestic tourism industry.

The rest of the paper is structured as follows. In section 2 we present and discuss the dynamic two sector model of a tourism dependent open economy. Section 3 reports and motivates the model's calibration. The impact effects and the dynamics caused by the COVID-19 shock in a baseline (and perhaps realistic) and an alternative scenario are discussed in detail in section 4. Section 5 contains sensitivity analysis with respect to the degree of financial openness, the price elasticity of foreigners' tourism demand, and the speed of recovery of foreigners' tourism demand. Section 6 concludes.

2 ANALYTICAL FRAMEWORK

This section draws heavily on Schubert (2013), where a more detailed representation of the model can be found. The dependent small open economy comprises two sectors, where four types of agents interact: households, firms in the industrial sector (I) and in the tourism sector (T), and foreigners.

2.1 Households

The economy is populated by many identical households. Each household can spend time to work (labor supply) in the industrial sector, l_I^s, and the tourism sector, l_T^s, and to search for a job in each sector, s_I and s_T, respectively. Agents who are searching for jobs are called unemployed agents. A household can work in one sector and search for a job in the same or in the other sector at the same time. Therefore, the model's definition of unemployment differs from the definition in official statistics. $l_I^s + l_T^s$ can be interpreted as working time(employment), and $s_I + s_T$ as searching time (unemployment). The labor force is defined as $l_I + l_T + s_I + s_T$, and the sectoral unemployment rates are defined as $UR_I \equiv s_I/(l_I + s_I)$ and $UR_T \equiv s_T/(l_T + s_T)$, respectively; the economy-wide unemployment rate is $UR \equiv (s_I + s_T)/(l_I + l_T + s_I + s_T)$. Each household consumes the internationally traded industrial good, c_I, and domestically produced tourism services, c_T (i.e.,

"holidays at home") For the sake of simplicity, we aggregate the domestic resident's spending on foreign tourism ("holidays abroad") into consumption of the traded industrial good, c_I.[4]

The representative household receives (i) wage income from working in the two sectors, $w_I l_I^s$ and $w_T l_T^s$, where wages w_I and w_T are denoted in terms of the industrial good, and (ii) profits Π_I and Π_T of the representative firms in the industrial and the tourism sector he owns. He uses his income for buying the industrial good, c_I, and tourism services, c_T, paying interest on his outstanding debt, $r \cdot z$, where r denotes the country specific interest rate, and accumulates debt, z.

The agent's flow budget constraint is given as

$$\dot{z} = c_I + pc_T + rz - w_I l_I - w_T l_T - \Pi_I - \Pi_T \tag{1a}$$

measured in terms of the industrial good, where p denotes the relative price of domestically produced tourism services in terms of the industrial good.[5]

Labor(employment) in the two sectors, l_I^s and l_T^s, changes only gradually according to

$$\dot{l}_I^s = \phi_I s_I - \zeta_I l_I^s \tag{1b}$$

and

$$\dot{l}_T^s = \phi_T s_T - \zeta_I l_T^s \tag{1c}$$

where ϕ_I and ϕ_T are the job finding rates in the two sectors' job markets, which the individual agent takes as given. ζ_I and ζ_T are the exogenously given rates of job separation. The representative household derives utility from consumption c_I and c_T and suffers disutility from working and/or searching in the economy's two sectors' labor markets. His instantaneous utility function is

$$U(c_I, c_T, l_I, l_T, s_I, s_T) = \frac{1}{\sigma}(c_I^\kappa c_T^{1-\kappa})^\sigma - \frac{\omega_I}{\theta_I}(l_I^s + s_I)^{\theta_I} - \frac{\omega_T}{\theta_T}(l_T^s + s_T)^{\theta_T} \tag{1d}$$

where κ denotes the weight of the industrial good in the agent's utility function. θ_I and θ_T are measures of the elasticities of labor supply, and ω_I and ω_T are weights associated with the disutilities from working and searching. Similar to Shi and Wen (1997, 1999); Heer (2003), the utility function is additively separable in consumption and labor/search in the two sectors.

The representative household maximizes his intertemporal utility W

$$\mathrm{W} \equiv \int_0^\infty \left(\frac{1}{\sigma}(c_I^\kappa c_T^{1-\kappa})^\sigma - \frac{\omega_I}{\theta_I}(l_I^s + s_I)^{\theta_I} - \frac{\omega_T}{\theta_T}(l_T^s + s_T)^{\theta_T}\right) e^{-\beta t} dt, \theta_I > 1, \theta_T > 1, \sigma < 1 \tag{1e}$$

by choosing the rates of consumption c_I and c_T, and search s_I and s_T, and the rates of debt accumulation and labor accumulation, subject to the flow constraints (1a), (1b) and (1c), and the given initial stocks of

[4] Rigorously, one can assume that c_I is an amalgam of the industrial good g and foreign tourism services f, e.g., $c_I = \Lambda g^\psi f^{1-\psi}, 0 < \psi < 1, \Lambda > 0$. Because the economy is small, the prices for the industrial good, p_g, and foreign tourism services, p_f, are given. Solving the expenditure minimization problem $\min_{g,f} p_g g + p_f f$ s. t. $\Lambda g^\psi f^{1-\psi} = 1$ gives a price index p_c. By proper choice of units, or by assuming without loss of generality $p_g = p_f = 1$, we can set $p_c = 1$, meaning that the price of one unit of c_I is unity.

[5] A dot over a variable denotes its time derivative, e.g. $\dot{x} \equiv \frac{dx}{dt}$, where t denotes time.

debt, $z(0) = z_0$, and labor $l_I(0) = l_{I0}$ and $l_T(0) = l_{T0}$. The intertemporal elasticity of substitution w. r. t. consumption is equal to $1/(1-\sigma)$. β denotes the given rate of time preference. Performing the optimization, the following first order conditions emerge:

$$\kappa c_I^{\kappa\sigma-1} c_T^{\sigma(1-\kappa)} = \lambda \tag{2a}$$

$$(1-\kappa) c_I^{\kappa\sigma} c_T^{\sigma(1-\kappa)-1} = p\lambda \tag{2b}$$

$$\omega_I (l_I^s + s_I)^{\theta_I - 1} = \gamma_I \phi_I \tag{2c}$$

$$\omega_T (l_T^s + s_T)^{\theta_T - 1} = \gamma_T \phi_T \tag{2d}$$

$$\frac{\dot{\lambda}}{\lambda} = \beta - r \tag{2e}$$

$$\frac{\lambda w_I}{\gamma_I} + \frac{\dot{\gamma}_I}{\gamma_I} - \zeta_I = \beta + \phi_I \tag{2f}$$

$$\frac{\lambda w_T}{\gamma_T} + \frac{\dot{\gamma}_T}{\gamma_T} - \zeta_T = \beta + \phi_T \tag{2g}$$

and the transversality conditions

$$\lim_{t\to\infty} \lambda z e^{-\beta t} = \lim_{t\to\infty} \gamma_I l_I^s e^{-\beta t} = \lim_{t\to\infty} \gamma_T l_T^s e^{-\beta t} = 0 \tag{2h}$$

where λ is the marginal utility of wealth in terms of traded bonds, and γ_I and γ_T denote the shadow prices of employment in the industrial sector and the tourism sector, respectively. Conditions (2a) and (2b) are static efficiency conditions, equating the marginal utility of consumption of to the marginal utility of wealth. Equations (2c) and (2d) equate the marginal cost of search (the disutility) in the two sectors' labor markets to the marginal benefit of search, (the rate of finding a job times the value of employment), respectively. The dynamic equation (2e) requires the rate of return on consumption to be equal to the rate of return on traded bonds, i.e., the interest rate. Equation (2f) requires the rate of return on employment in the industrial sector, comprising the "dividend yield" of employment, $\lambda w_I/\gamma_I$, the "capital gain" $\dot{\gamma}_I/\gamma_I$ and the loss due to job destruction ζ_I, to be equal to the "effective" discount rate $\beta + \phi_I$. Equation (2g) can be interpreted in a similar way. Finally, in order to ensure that the agent's intertemporal budget constraint is met, the transversality conditions (2h) must hold.

The two static first order conditions (2a) and (2b) can be solved for the two rates of consumption in terms of the marginal utility of wealth λ and the relative price p:

$$c_I = c_I(\lambda, p) = \kappa^{\frac{1}{1-\sigma}} \left(\frac{1-\kappa}{\kappa}\right)^{\frac{\sigma(1-\kappa)}{1-\sigma}} \lambda^{-\frac{1}{1-\sigma}} p^{-\frac{\sigma(1-\kappa)}{1-\sigma}} \tag{3a}$$

$$c_T = c_T(\lambda, p) = \kappa^{\frac{1}{1-\sigma}} \left(\frac{1-\kappa}{\kappa}\right)^{\frac{1-\sigma\kappa}{1-\sigma}} \lambda^{-\frac{1}{1-\sigma}} p^{-\frac{1-\sigma\kappa}{1-\sigma}} \quad (3b)$$

Provided that the intertemporal elasticity of consumption $1/(1-\sigma)$ is smaller than unity (i.e. $\sigma < 0$), what empirical evidence overwhelmingly suggests, it follows from equations (3a) and (3b) that the resident's consumption rates depend negatively on the marginal utility of wealth and on the relative price of tourism services (with $\partial c_I / \partial p > 0, \partial c_T / \partial p < 0$, reflecting the substitution effect).

2.2 Firms

2.2.1 Firms in industrial sector

The economy comprises a large number of identical firms in the industrial sector, producing the industrial good, y_I, by using labor (demand), l_I^d, by means of the Cobb-Douglas production function

$$y_I = A_I (l_I^d)^{\alpha_I}; \quad 0 < \alpha_I < 1 \quad (4a)$$

where $A_I(t)$ denotes total factor productivity, which is a function of time, and α_I denotes the share of labor in production.[6]

Since each sector is distinguished by its own, separated labor market, given the sectoral job separation rate ζ_I, the individual firm takes rate φ_I of successfully filling a vacancy v_I as given. Employment dynamics of each representative firm in the industrial sectors follows as

$$\dot{l}_I^d = \varphi_I v_I - \zeta_I l_I^d \quad (4b)$$

The firm has to pay a cost for maintaining a number of job vacancies equal to $m_I v_I$. This cost includes advertising costs (Pissarides, 1987), hiring/recruiting costs (Pissarides, 1986), Mortensen and Pissarides (1994), and costs of a human resources division. The firm's profit is given as

$$\Pi_I = y_I - w_I l_I^d - m_I v_I \quad (4c)$$

The firm's objective is to maximize the value of the firm, i.e. the present value of profits, V_I

$$V_I \equiv \int_0^\infty \Pi_I(t) e^{-\int_0^t r(\tau) d\tau} dt \quad (5)$$

by choosing the number of vacancies v_I to be posted, and the rate of accumulating labor l_I^d, subject to equations (4a) - (4c) and the initial stock of labor, $l_I^d(0) = l_{I0}^d$.

Solving the firm's optimization problem gives rise to the following first order conditions:

$$m_I = \xi_I \varphi_I \quad (6a)$$

[6] Despite the fact that we do not explicitly model physical capital, the (fixed) sectoral capital stocks can be thought as included in total factor productivity A.

$$\frac{\alpha_I A_I \left(l_I^d\right)^{\alpha_I - 1}}{\xi_I} + \frac{\dot{\xi}_I}{\xi_I} - \frac{w_I}{\xi_I} - \zeta_I = r(\cdot) \tag{6b}$$

$$\lim_{t\to\infty} \xi_I l_I^d e^{-\int_0^t r(\tau)d\tau} = 0 \tag{6c}$$

ξ_I denotes the shadow price of labor. Equation (6a) equates the marginal cost of vacancy to its marginal benefit, that is, the value of a filled position ξ_I times the probability of filling it. No-arbitrage relation (6b) equates the rate of return on labor, comprising a "dividend yield", a "capital gain", and two losses due to wage payments and job destruction, to the interest rate, r. Finally, the transversality condition (6c) must hold.

2.2.2 Firms in the tourism industry

The tourism sector is characterized by a large number of identical firms, too. They are characterized in a similar way as firms in the industrial sector, i.e.,

$$y_T = A_T (l_T^d)^{\alpha_T}; \quad 0 < \alpha_T < 1 \tag{7a}$$

$$\dot{l}_T^d = \varphi_T v_T - \zeta_T l_T^d \tag{7b}$$

$$\Pi_T = p y_T - w_T l_T^d - m_T v_T \tag{7c}$$

Note that profits of tourism firms are measured in terms of the industrial good. Maximization of the tourism firm's value

$$V_T \equiv \int_0^\infty \Pi_T(t) e^{-\int_0^t r(\tau)d\tau} dt \tag{8}$$

gives rise to similar first order conditions as for industrial firms, namely

$$m_T = \xi_T \varphi_T \tag{9a}$$

$$\frac{p\alpha_T A_T \left(l_T^d\right)^{\alpha_T - 1}}{\xi_T} + \frac{\dot{\xi}_T}{\xi_T} - \frac{w_T}{\xi_T} - \zeta_T = r(\cdot) \tag{9b}$$

$$\lim_{t\to\infty} \xi_T l_T^d e^{-\int_0^t r(\tau)d\tau} = 0 \tag{9c}$$

which have the same interpretation as before. Total factor productivity $A_T(t)$ is a function of time, too.

2.3 Goods and service markets

The domestic economy is small in the world market for the industrial good. Any excess/shortfall of domestic production y_I over domestic demand inclusive resources needed for job postings $c_I + m_I v_I + m_T v_T$ can always be exported/imported at the world market for industrial goods, without influencing the relative price p.

In contrast, domestically produced tourism services can be distinguished from tourism services produced elsewhere. The economy thus faces a demand function of foreigners for domestically produced tourism services which depends on the relative price p. We assume that the demand function is of the constant price elasticity form

$$E(p, D) = D(t)p^{-\eta_T} \tag{10}$$

where $D(t)$ is a time dependent demand shift parameter, and η_T denotes the absolute value of the price elasticity of foreigners' demand for domestically produced tourism services.

The equilibrium in the tourism market requires that supply equals demand:

$$A_T l_T^{\alpha_T} = c_T(\lambda, p) + E(p, D) \tag{11}$$

Given time paths of labor l_T, total factor productivity A_T, the marginal utility of wealth λ, and the demand shift variable $D(t)$, the market for domestically produced tourism services remains cleared by proper adjustments of the relative price of tourism services, p.

2.4 Matching and wage determination

As in Shi and Wen (1997, 1999), Heer (2003), Schubert (2011), and Heer and Schubert (2012), labor markets are subject to frictions and are characterized by two-sided search. Matching vacancies with searching agents is a time-consuming process. To simplify notation, v_I, v_T and s_I, s_T also denote the aggregate numbers of vacancies and searching agents in both sectors, respectively. For each sector we assume a constant return to scale matching technology of the Cobb-Douglas form

$$M_I(v_I, s_I) = B_I v_I^{\chi_I} s_I^{1-\chi_I}, \quad B_I > 0, 0 < \chi_I < 1 \tag{12a}$$

$$M_T(v_T, s_T) = B_T v_T^{\chi_T} s_T^{1-\chi_T}, \quad B_T > 0, 0 < \chi_T < 1 \tag{12b}$$

In what follows, we concentrate on the industrial sector's labor market, as the tourism sector's labor market works in an analogous way.

Matches per unemployed agent in the industrial sector can be expressed as $\phi_I = B_I(v_I/s_I)^{\chi_I}$, and matches per vacancy as $\varphi_I = B_I(v_I/s_I)^{\chi_I - 1}$. Hence, the rates of finding a job and of filling a vacancy are endogenously determined, whereas households and firms rationally take them as given. The same holds for the tourism sector.

Once an unemployed agent is matched with a vacancy, the agent and the firm negotiate the time path of the agent's wage rate w_I. Wages are measured in terms of the industrial good and are determined by Nash bargaining.

Denoting $0 < \rho_I < 1$ as the bargaining power of workers in the industrial sector, the solution of the Nash bargaining game gives the wage rate

$$w_I = \rho_I \alpha_I A_I (l_I^d)^{\alpha_I - 1} + (1 - \rho_I) \frac{\omega_I (l_I^s + s_I)^{\theta_I - 1}}{\kappa c_I^{\kappa\sigma - 1} c_T^{\sigma(1-\kappa)}} \tag{13}$$

The wage rate bargained in the industrial sector is a weighted average of the marginal product of labor and the agent's reservation wage $\left(\frac{\omega_I\left(l_I^S+s_I\right)^{\theta_I-1}}{\kappa c_I^{\kappa\sigma-1}c_T^{\sigma(1-\kappa)}}\right)$ for working in the industrial sector.

The wage bargaining process in the tourism sector is analogous and results in the wage rate (measured in terms of the industrial good)

$$w_T = \rho_T p\alpha_T A_T (l_T^d)^{\alpha_T-1} + (1-\rho_T)\frac{\omega_T\left(l_T^S+s_T\right)^{\theta_T-1}}{\kappa c_I^{\kappa\sigma-1}c_T^{\sigma(1-\kappa)}} \tag{14}$$

The bargained wage rate is a weighted average of the marginal value product of labor in the tourism sector and the agents' reservation wage for working in the tourism sector, where the weight ρ_T denotes workers' bargaining power in the tourism sector.

2.5 The international financial market and the current account

The economy has access to the international financial market, and has the possibility borrow internationally. However, it faces restrictions on doing so, according to lenders' assessment of credit worthiness. We incorporate this by assuming that the country is charged a country specific risk premium, ν, which is an increasing function of the ratio of the country's stock of foreign debt, z, and its GDP, $y_I + py_T$, measured in terms of the traded good. The interest rate r the economy faces is determined as

$$r(z, y_I, y_T, p) = r^* + \nu\left(\frac{z}{y_I+py_T}\right); \quad \nu'(\cdot) > 0 \tag{15}$$

where r^* denotes the exogenously given riskless world interest rate. Equation (15) represents an upward sloping supply curve of debt, see, e.g., Turnovsky (1997, ch. 2). In making his decisions, the representative household takes the interest rate as given. In making his decisions, the representative household takes the interest rate as given. This is because the interest rate facing the nation depends on its aggregate debt, which the agent, being atomistic, rationally assumes that he cannot influence.

Combining the agent's flow budget constraint (1a) with the definition of profits (4c) and (7c) gives the national budget constraint

$$\dot{z} = c_I + pc_T + m_I v_I + m_T v_T + rz - y_I - py_T \tag{16}$$

which is the negative of the current account.[7] It states that the nation accumulates foreign debt to finance its expenditures on the industrial good and on domestic tourism services, on advertising, vacancy costs, and interest payments on outstanding debt net of the value of output (GDP). Inserting (11) into (16), debt accumulation $\dot{z}$ can equivalently be written as

$$\dot{z} = [c_I + m_I v_I + m_T v_T - y_I - pE(p, D)] + rz \tag{17}$$

where the expression in brackets is the negative of the economy's trade balance, expressed in terms of the industrial good. Finally, the intertemporal budget constraint

$$\lim_{t\to\infty} z(t)e^{-\int_0^t r(\tau)d\tau} = 0 \tag{18}$$

[7] Remember that z denotes debt.

must hold.

2.6 Structure of the COVID-19 shock

The outbreak of the COVID-19 pandemic caused the economy's lockdown as well as an ebbing in tourism. On the supply side, firms' shutdowns and interrupted or broken supply chains caused total factor productivities A_I and A_T to drop, and labor employed in both sectors was reduced along the shutdown and due to workers' infections. On the demand side, international tourism arrivals ran dry. We model these effects as exogenous drops at time $t = 0$ in the initial amount of labor employed in the industrial and in the tourism sector, $l_I(0), l_T(0)$, respectively, and instantaneous exogeneous reductions in the two total factor productivities, $A_I(0)$ and $A_T(0)$. The tremendous drop in international tourism demand is modelled by an exogenous reduction in the demand shift parameter $D(0)$. After their initial reductions, employment in both sectors follow the dynamic equations (1b) and (1c). Total factor productivities and the demand shift parameter obey the following laws of motion:

$$\dot{A}_I = \delta_I(\tilde{A}_I - A_I(t)) \tag{19a}$$

$$\dot{A}_T = \delta_T(\tilde{A}_T - A_T(t)) \tag{19b}$$

$$\dot{D} = \delta_D(\tilde{D} - D(t)) \tag{19c}$$

Variables with a tilde are long-run steady state values, and the parameters $\delta_I, \delta_T, \delta_D$ are the speeds of adjustment of the three shock variables. Equations (2.6) state that productivities and the demand shift parameters eventually return to their steady state values.

2.7 Macroeconomic equilibrium

The macroeconomic equilibrium is defined in Schubert (2013) and discussed there.

The economy's dynamics can be expressed as a system of twelve first order differential equations in terms of z, l_I, l_T, λ, s_I, s_T, x_I, x_T, p, A_I, A_T, and D. The dynamic system is derived and reported in the appendix of Schubert (2013).[8]

3 CALIBRATION STRATEGY

Due to the model's complexity, we resort to numerical simulations, based on a reasonable calibration, which on average fits a wide range of countries. We explicitly do not focus on any particular country, as such a

[8] Because of the time dependent total factor productivities and demand shift parameter, in our model the dynamics of the relative price is given by

$$\dot{p} = \frac{\alpha_T A_T l_T^{\alpha_T - 1}}{\Lambda_1}\dot{l}_T + \frac{\Lambda_2}{\Lambda_1}\dot{\lambda} + \frac{l_T^{\alpha_T}}{\Lambda_1}\dot{A}_T - \frac{\tilde{p}^{-\eta_T}}{\Lambda_1}\dot{D}$$

where

$$\Lambda_1 = -\left[\left(\frac{1-\sigma\kappa}{1-\sigma}\right)\left(\frac{1-\kappa}{\kappa}\right)^{\frac{1-\sigma\kappa}{1-\sigma}}\kappa^{\frac{1}{1-\sigma}}\tilde{\lambda}^{-\frac{1}{1-\sigma}}\tilde{p}^{-\frac{1-\sigma\kappa}{1-\sigma}-1} + \eta_T\tilde{D}\tilde{p}^{-(\eta_T+1)}\right]$$

$$\Lambda_2 = \left(\frac{1}{1-\sigma}\right)\kappa^{\frac{1}{1-\sigma}}\left(\frac{1-\kappa}{\kappa}\right)^{\frac{1-\sigma\kappa}{1-\sigma}}\tilde{\lambda}^{-\frac{1}{1-\sigma}-1}\tilde{p}^{-\frac{1-\sigma\kappa}{1-\sigma}}$$

strategy could be problematic.[9] Table 1 reports the parameters for the benchmark economy; they are similar to those in Schubert (2013).

Table 1 - Baseline calibration

Preference parameters	$\beta = 0.04, \sigma = -0.5, \kappa = 0.95$
	$\omega_I = 60, \theta_I = 3, \omega_T = 300, \theta_T = 2.5$
Production parameters	$\tilde{A}_I = 0.7, \alpha_I = 0.64, \tilde{A}_T = 0.25, \alpha_T = 0.75$
Labor market parameters	$\chi_I = 0.5, \zeta_I = 0.105, \rho_I = 0.5, B_I = 1.25, m_I = 0.7$
	$\chi_T = 0.5, \zeta_T = 0.155, \rho_T = 0.5, B_T = 1.5, m_T = 0.3$
Foreign tourism demand	$\widetilde{D}_0 = 0.03, \eta_T = 1.75$
Interest rate rule	$r^* = 0.02, \vartheta = 0.04$
Speed of adjustments	$\delta_I = 2.5, \delta_T = 2.5, \delta_D = 0.4$

Time is measured in years. A time preference rate $\beta = 0.04$ implies a 4% steady-state real interest rate. The preference parameter σ is set equal to -0.5, reflecting an empirically plausible intertemporal elasticity of substitution of 2/3. The industrial good's weight κ in the agent's preferences is set equal to 0.95. Together with the demand shift parameter $\widetilde{D}_0 = 0.03$ the share of foreigners' tourism demand (i.e., tourism exports) in tourism production is 60.1%. This seems to be a plausible value, as residents also consume services produced by the domestic tourism industry, e.g., frequenting restaurants, or spend at least part of their holidays within the country.

The values θ_I and θ_T imply elasticities of sectoral labor supply with respect to the wage rate equal to 1/2 and 2/3, respectively.[10] The values of ω_I and ω_T have been set in a way to yield – along with the other parameters of the labor market – an equilibrium fraction of time devoted to leisure of roughly 0.7, consistent with empirical observations.

The exponents of labor in the sectoral production functions, $\alpha_I = 0.64$ and $\alpha_T = 0.75$, are within the empirically plausible range and indicate that the tourism sector is more labor intensive than the industrial sector. Taking into account that the industrial sector is more productive than the tourism industry, the baseline steady-state total factor productivities A_I and A_T have been set to imply – together with other parameters – a plausible share of the tourism sector in GDP of 11.7%. The share of labor employed in the tourism industry is 16.3%.

The bargaining power of workers and firms in the two labor markets is assumed to be equal: $\rho_I = \rho_T = 0.5$. The same is assumed for the exponents $\chi_I = \chi_T = 0.5$ in the two matching functions. ζ_I is set equal to an annual job separation rate in the industrial sector of 10.5%, and ζ_T implies an annual job separation rate in the tourism industry equal to 15.5%, reflecting a higher fluctuation in the tourism industry.[11] The two matching parameters B_I and B_T are set to 1.25 and 1.5, respectively, taking into account that it is easier to match workers and firms in the tourism sector than in the industrial sector, due to lower job and qualification requirements. Together with the preference parameters and vacancy costs, labor market equilibrium is characterized by the following plausible unemployment rates: The unemployment rate in the industrial sector equals 8.33%, the unemployment rate in the tourism service sector is 7.44%, and the economy-wide unemployment rate amounts to 8.18%.

The price elasticity of foreigners' tourism demand η_T is set to 1.75 and is located within the plausible range.[12] The resulting equilibrium relative price of tourism services p is 1.48.[13]

The riskless world interest rate is set to 2%. Together with the parameter of the interest rate function equal to $\vartheta = 0.04$, which proxies almost unlimited access to the international financial markets, the equilibrium debt-GDP ratio is 49.5%.

[9] On the issue of calibration and why calibrating the model to a particular economy may be problematic, see Turnovsky (2011).
[10] The wage elasticity of labor supply is $\varepsilon_j = 1/(\theta_j - 1); j = I, T$.
[11] See Hobijn and Şahin (2009), who estimated monthly job separation rates for 23 OECD countries.
[12] Empirical evidence suggests that the price elasticity may be quite low. Lanza, Temple, and Urga (2003) derived price elasticities in the range between 1.03 and 1.82.
[13] Note that this value is not of any significance, as it is always possible to obtain an initial value of $p = 1$ by proper choice of units.

The benchmark speeds of adjustment for the total factor productivities, δ_I, δ_T, and the demand parameter δ_D are set to 2.5, 2.5 and 0.4, respectively, signifying that productivities recover much faster than international tourism demand.

For all reasonable parameter values, the linearized dynamic system has 6 unstable and 6 stable roots, corresponding with the six sluggish variables z, l_I, l_T, A_I, A_T, and D.

The first column of Table 2 reports equilibrium values of key economic variables in the benchmark economy, expressed in percentages. The table's first section reports the values in case of the baseline scenario, whereas the second section contains the values obtained in an alternative scenario. In each section, the first part compares the variables' values to their benchmark, whereas the second part report shares, unemployment rates, and the debt-GDP ratio.[14] The benchmark relative wage, w_T/w_I, equals 81% (not reported), implying that the bargained wage rate in the tourism sector is roughly 4/5 as high as the industrial sector's wage. [p]

[14] Note that the model does not contain a government; hence all debt is private and is incurred on the international financial market.

Table 2 - Benchmark and dynamic equilibria (expressed in percent)

	benchmark	on impact	after one quarter	after one year	after two years
			1. Baseline scenario		
Industrial production (compared to benchmark)	100	88.07	92.25	98.09	100.1
Tourism service production (compared to benchmark)	100	80.37	85.78	92.89	95.98
GDP (compared to benchmark)	100	85.79	89.88	95.92	98.47
Labor industrial sector (compared to benchmark)	100	86	90.42	97.41	100.2
Labor tourism sector (compared to benchmark)	100	86	87.71	91.64	94.76
Foreigners' tourism demand (compared to benchmark)	100	66.12	74.4	87.34	93.93
Share industrial production in GDP	88.3	90.66	90.63	90.31	89.78
Share tourism services production in GDP	11.7	9.34	9.37	9.69	10.22
Share tourism exports in tourism production	60.1	49.44	52.13	56.51	58.82
Unemployment rate industrial sector	8.33	23.05	18.91	12.14	9.23
Unemployment rate tourism sector	7.44	11.68	11.23	9.84	8.86
Overall unemployment rate	8.18	21.4	17.78	11.79	9.17
Debt-GDP ratio	49.5	57.71	59.31	61.14	60.86
			2. Alternative scenario		
Industrial production (compared to benchmark)	100	81.72	**85.02**	**91.23**	95.31
Tourism service production (compared to benchmark)	100	75.91	78.14	83.8	89.3
GDP (compared to benchmark)	100	79.81	83.04	89.34	93.78
Labor industrial sector (compared to benchmark)	100	86	90.0	96.56	99.67
Labor tourism sector (compared to benchmark)	100	86	87.42	91.0	94.37
Foreigners' tourism demand (compared to benchmark)	100	64.92	69.7	80.54	89.51
Share industrial production in GDP	88.3	90.42	90.41	90.17	89.74
Share tourism services production in GDP	11.7	9.58	9.59	9.83	10.26
Share tourism exports in tourism production	60.1	51.4	53.61	57.76	60.24
Unemployment rate industrial sector	8.33	22.05	18.34	12.38	9.28
Unemployment rate tourism sector	7.44	11.29	10.96	10.06	9.18
Overall unemployment rate	8.18	20.47	17.25	12.03	9.64
Debt-GDP ratio	49.5	62.03	65.12	69.76	71.18

4 THE COVID-19 SHOCK

Starting from the benchmark equilibrium, we investigate the economic dynamics caused by the COVID pandemic. In an attempt to combat the virus, almost all affected countries imposed a lockdown on the economy. Firms, shopping malls, stores, hotels, tourism facilities, and so on were closed, and people were not allowed to enter or leave a building or area freely. The lockdown has severe consequences for the economy. On the one hand, the supply side is negatively affected in various ways. Firms' shutdown means lower production of goods and services and laid-off workers. Business relationships are interrupted, and supply chains break. As a consequence, some firms will suffer bankruptcy, and jobs offered by those firms are destroyed, and their workers become unemployed. On the other hand, the lockdown impinges negatively on aggregate demand. Consumption of some goods and services may fall, and because of travel restrictions, the arrival of international tourists plunges dramatically, strongly reducing foreigners' demand for domestically produced tourism services. We model these effects caused by COVID as a multiple shock by (i) reduced sectoral total factor productivities, reflecting broken supply chains, bankruptcies, and less effective allocation of production factors, (ii) a reduction in labor employed, and (iii) a sharp decline in international tourism demand.

We distinguish two scenarios: a baseline scenario, which seems to be realistic at the moment of writing, assuming that productivities recover quickly (i.e., that supply chains can be quickly readopted, reducing thus misallocation of production factors), and an alternative scenario, in which – perhaps because of further lockdowns – productivity in the aftermath of the shock adjusts only slowly. On impact, that is during the lockdown, labor employed is assumed to drop by 14% in both sectors, following the International Labor Organization, which reports a 14% loss of working hours worldwide (see Ilo, 2020). In the baseline scenario, the productivity in the industrial sectors falls by 3%, whereas productivity in the tourism industry drops by 10%, reflecting the fact that the tourism sector was hit particularly hard (see World Bank, 2020). During the lockdown crisis, a lot of firms in the tourism industry completely lost their business due to travel restrictions. In the alternative scenario – prolonged or repeated lockdown, more broken supply chains –, the industrial sector's productivity is assumed to drop by 10% and the tourism industry's TFP by 15%.[15]

Turning to foreigners' tourism demand, for a given relative price of tourism services, p, we assume a 50% demand reduction, which is a reasonable value [see, e.g. UNWTO (2020b), which detected a 56% drop in tourist arrivals compared to 2019, and UNWTO (2020b), recording that international tourism is down by 44% during January – April 2020, or ECLAC (2020), United Nations (2020), and IATA (2020), ICAO (2020), which report reductions in air travel demand, which serves as a proxy for international tourist arrivals (see UNWTO, 2020b, p. 4), of more than 50%.]. Table 3 reports the shocked levels of sectoral labor and productivities in the two scenarios, compared to the benchmark equilibrium (in which variables are set equal to 100), and the supposed speeds of convergence.

Table 3 - Shock parameters, compared to benchmark equilibrium, and speeds of convergence

	$l_I(0)$	$l_T(0)$	$A_I(0)$	$A_T(0)$	$D(0)$	δ_I	δ_T	δ_D
Baseline scenario	86	86	97	90	50	2.5	2.5	0.4
Alternative scenario	86	86	90	85	50	0.4	0.4	0.4

4.1 Baseline scenario

In the baseline scenario, the speed of adjustment (or convergence) of sectoral factor productivities is assumed to be fast: We therefore set $\delta_I = \delta_T = 2.5$, which implies that (in our continuous time model) the rate at which the A_I and A_T recover towards their steady states $\left(\frac{\dot{A}_j(t)}{\bar{A}_j - A_j(t)}\right)$ equals 250%.[16] The tourism demand parameter D is assumed to have a speed of convergence of $\delta_D = 0.4$. Figure 1 plots the time paths of labor,

[15] We also simulated the shock with initial productivity reductions of 3% in both sectors. Interestingly, the dynamics and the quantitative behaviour of the economy does barely change. The main difference to the optimistic scenario is an initially smaller tourism production drop, accompanied by a larger market clearing reduction in the relative price p and a slightly higher initial unemployment rate in the tourism sector.

[16] Note that this does NOT imply that it takes much less than a year to reach the steady state; in fact, the steady state is approached at infinity. Reducing, e.g., A_T by 10%, an adjustment speed $\delta_T = 2.5$ implies that it takes 0.693 years (8 months and 10 days) until A_T has reached a level equal to 95% of its benchmark.

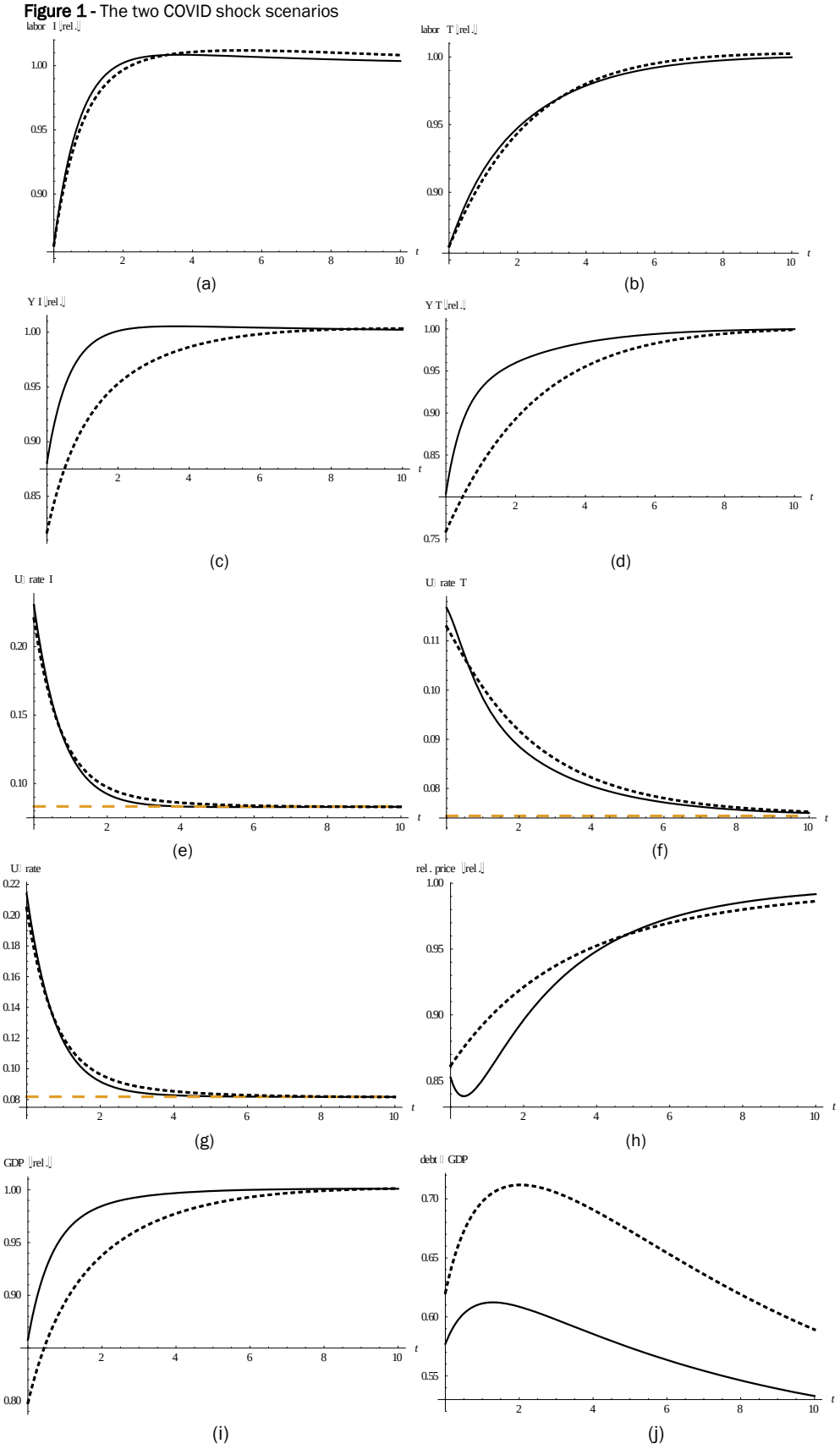
output, GDP, and the price p relative to their benchmark values, and shows also the paths of unemployment rates and the debt-GDP ratio. The solid paths correspond to the baseline scenario.

4.1.1 Impact effects

In the first section of Table 2, the second column reports the impact effects on key economic variables. As the COVID shock hits the economy, labor in both sectors drops by 16%, and together with the productivity reductions of 3% and 10% in the industrial and the tourism sector, respectively, industrial output immediately falls to roughly 88% of its pre-shock level (in reality, e.g., ECLAC (2020) reports reductions in industrial production of 15.1% in Brazil, 14.1% in Chile, and 20.1% in Columbia for April 2020). Tourism service production is reduced to approximately 80% of its pre-crisis value. Together with the relative price effect (discussed below), GDP plunges to 85.8%, causing a deep recession. This number is quite realistic. For example, according to Eurostat (2020), GDP in the Euro zone fell by 12.1% in the first quarter 2020 compared to the previous quarter; the reduction in Spain (18.5%), Italy (17,3%), and France (13.8%) was even larger.

The breakdown of airline connections and the associated sharp drop of international tourist arrivals causes a strong reduction in foreigner's tourism demand (by 50%, given the relative price), which is by far larger than tourism service production. Tourism service market clearing requires a reduction in the relative price for tourism services. This causes a substitution effect for domestic residents' consumption of industrial goods and domestic tourism services. They will substitute away from industrial goods and will increase their demand for domestic tourism services ("holidays at home"). On the other hand, the recession results in a negative wealth effect (in terms of the model, the marginal utility of wealth λ rises), which induces residents to decrease demand of both goods and services (see equations 2.1). In sum, the substitution effect and the wealth effect reinforce each other in case of the industrial good, and its demand from domestic households falls. In case of tourism services, the substitution effect and the wealth effect run in opposite directions, and according to our numerical simulations, the former effect outweighs the latter, increasing thus residents' demand for domestic tourism services. In fact, this is what happened (and still happens) in 2020: Because of the pandemic and travel restrictions, a lot of households do not travel, but spend their holidays at home or in their region (or country), thus consuming "domestically". On the tourism service market, this helps to dampen the price erosion; the relative price p will fall by roughly 15% (see panel h in Figure 1). The lower relative price stimulates foreigners' tourism service demand a little bit, resulting in an overall reduction of foreigners' tourism demand to approximately 66% of its pre-shock level. This is in line with recent empirical evidence. ECLAC (2020) reports a reduction in international tourism arrivals by roughly 35% in South America and Central America, and by 39% in the Caribbean.

Figure 1 - The two COVID shock scenarios



On the labor market, workers who lost their jobs in the two sectors immediately flow into the sectoral unemployment pools (industrial and tourism sector, respectively).[17] By definition, this increases the sectoral unemployment rates $s_I/(l_I + s_I)$ and $s_T/(l_T + s_T)$ and the economy-wide unemployment rate $(s_I + s_T)/(l_I + l_T + s_I + s_T)$, see panels e, f, and g in Figure 1, where the long-dashed grey lines represent the unemployment rates in the benchmark equilibrium. But this is not the only effect on unemployment and thus unemployment rates. As productivity in the industrial sector falls only slightly, firms still post a sufficiently high number of jobs, which raises the probability of finding a job. Together with an increased value of a job in the industrial sector, households have an incentive to increase their search for jobs in the industrial sector, amplifying the effect on search the reduction in labor causes. Thus, search in the industrial sector increases by a large amount, raising thus the sectoral unemployment rate to roughly 23%. In the tourism industry however, which is much harder hit by the shock (productivity falls by 10%), firms will only post a few jobs, and this reduces the probability to find a job. The reduced wage (not shown in the table and the figure) and consequently a lower value of a job in the tourism industry dampen the household's incentive to search for a job in the tourism sector. This partially offsets the one-to-one effect of the reduction in labor in the tourism sector, and search in that sector increases only by a small amount. As a result, the unemployment rate in the tourism industry rises only to approximately 11.7%. The economy-wide unemployment rate shoots up to 21.4%, where this sharp increase is mainly driven by the industrial sector.

The huge drop in GDP increases the debt-GDP ratio to 57.7%, and as a consequence, the interest rate increases from 4% to 4.35%. Because GDP falls by more than households' consumption and higher interest payments on the outstanding debt, the current account turns into deficit, initiating an accumulation of (net) foreign debt.

4.1.2 Dynamic transition

The COVID shock initiates dynamics, as total factor productivities, labor and tourism demand changed on impact. As time passes, the two sectoral productivities A_T and A_I increase, and this raises production, given labor. In addition, households' increased search efforts in both sectors raises employment (labor) in both sectors over time, and this additionally contributes to higher sectoral productions. This can be read off from the third column in Table's 2 first section, where the key variables' values one quarter after the shock are reported. Labor in the industrial sector increased by more than four points to 90.4% of the benchmark level, and employment in the tourism industry improves to 87.7% relative to the benchmark. This increases industrial output to 92.25% and tourism sector production by more than five points to 85.8% relative to the benchmark. GDP recovers by slightly more than 4 points to 89.9%. The share of tourism production in GDP is more than two points lower than in the benchmark equilibrium. More employment together with declining unemployment reduces unemployment rates. The unemployment rate in the industrial sector falls by roughly 3 points, the one in the tourism sector slightly to 11.23%. This reduces the overall unemployment rate from initially 21.4% to roughly 17.8%. Because the increase in tourism production is larger than the increase in foreigners' tourism demand – due to the dynamic transition of the demand shift parameter D – and the rise in domestic residents' tourism service demand, domestic tourism market clearance requires a fall in the relative price p. In fact, as can be seen in panel h of Figure 1, the relative price reaches a minimum roughly two quarters after the shock emerged, and increases from thereon. Foreigners' tourism demand has risen to 74.4%, due to both the increase in the demand recovery and the lower relative price. The economy's debt-GDP ratio increases to 57.7%, as the economy runs a current account deficit, and debt grows faster than GDP.

One year after the shock, the dynamics has moved the economy into a state where labor in the industrial sector has already reached 97.4% of its benchmark level, whereas in the tourism industry labor is still more than 8 points below the benchmark. This is due to the fact that the tourism industry was hit much more by the shock than the industrial sector. Industrial output is now at 98.1%, whereas tourism service production equals only 92.9% of its benchmark level. GDP has recovered to 95.9% and is thus roughly 4 points under

[17] This can be shown formally by solving the households first order conditions (8) and (9) for s_I and s_T, which gives the two sectoral searches s_I and s_T as functions of sectoral labor and the sectoral shadow utility value of a job times the sectoral probability to find a job. The partial derivatives with respect to sectoral labor are $\partial s_I/\partial l_I = -1$ and $\partial s_T/\partial l_T = -1$.

its long-run equilibrium. The economy has partially recovered from the shock, but is still suffering, as the unemployment rates show, too. The unemployment rate in the industrial sector equals 12.14%, the one in the tourism sector is 9.84%, which results in an economy-wide unemployment rate of 11.8%, which is more than 3.5 points above its steady-state level. The evolution of tourism demand (both by foreigners and by domestic residents) has moved back the relative price to its level it took on impact. Foreigners' tourism demand equals roughly 87% of its pre-shock level. The debt-GDP ratio has risen further, as the economy still runs a current account deficit (partially due to higher interest payments), and debt growth faster than GDP.

As the recovery continues, two years after the shock labor in the industrial sector is marginally above its benchmark level, whereas in the tourism sector labor is still 5.25 points lower than in the long run. Together with the ongoing productivity improvements, industrial production has reached its pre-shock level (indeed, it is slightly above), and tourism service production is at 96%, resulting in a GDP of roughly 98.5%. The sectoral unemployment rates are 9.23% (industrial sector) and 8.86% (tourism sector), and the overall unemployment rate has fallen to 9.17%, but is still one point above its steady state. Foreigners' tourism demand recovered to roughly 94%. According to recent estimations this seems to be a plausible scenario (see Iata, 2020).

Debt peaks roughly two years after the shock and falls from thereon, but the positive economic development results in a small reduction in the debt-GDP ratio to 60.86% (panel j).

As the time paths in Figure 1 show, the economy evolves gradually towards its steady state (its benchmark), but this occurs slowly. One can also see that industrial production slightly overshoots its benchmark value and has thus fully recovered after two years, whereas tourism service production needs much more time to fully recover. This is due to the fact that (i) the productivity shock was bigger, and (ii) that foreigners' tourism demand has initially fallen by a huge amount. Indeed, it takes roughly ten years until tourism service production equals its pre-shock level. Interestingly, the tourism sector's slow recovery compared to the industrial sector does not depend on the initially larger productivity drop in the tourism industry, but is mainly caused by the huge initial shortfall in foreigners' tourism demand.[18] Foreigners' tourism demand approaches its pre-shock level after roughly six years.

We can summarize that the COVID shock shows severe effects, that it takes more than half a decade to restore foreigners' tourism demand and that the industrial sector and the tourism industry recover at different speeds.

4.2 Alternative scenario

In the alternative scenario, we assume slow speeds of adjustment of sectoral factor productivities and set $\delta_I = \delta_T = 0.4$, so that the speed of recovery equals 40%. In addition, we assume deeper productivity shocks and reduce A_I to 90% and A_I to 85% of its pre-shock levels (see Table 3). The shock on foreigners' tourism demand remains unchanged. Reasons could be that more firms go bankrupt, and more supply chains break, as well as a possible second wave of the virus results in a second lockdown.[19] In Figure 1 the time paths for the alternative scenario are dashed. The values of important key variables are reported in the second section of Table 2. As the responses to the shock are similar to the ones in the baseline scenario, we can be brief here.

4.2.1 Impact effects

The second section of Table 2 reports the impact effects in its second column. Compared to the baseline scenario, the reductions in industry and tourism production and so GDP are bigger, because the productivity shocks are greater. Interestingly, the increases in the sectoral and overall unemployment rate(s) are a little bit dampened; e.g., the economy wide unemployment rate rises by roughly one point less to 20.47%. The reason can be found in stronger wage decreases, which are due to bigger productivity losses. These lower the values of a job and reduce households' incentives to search for jobs in the two sectors, resulting in smaller

[18] We simulated the model with equal productivity reductions of 3% in both sectors, too. The results barely change. See also footnote 4.

[19] Strictly speaking, a second lockdown should be modelled in a different way as a second shock which hits the economy at some future time T (e.g., six months after the first shock). We view our approach only as a rough approximation of a second lockdown. An exact modelling would tremendously increase the model's complexity.

sectoral unemployment rates. Because GDP falls by more, the debt-GDP ratio rises by a bigger amount to 62%. Note that the relative price p falls by less than in the baseline scenario. The reason is that the supply reduction due to the shock is larger, therefore the necessary reduction in the relative price to equilibrate the tourism market is smaller.

4.2.2 Dynamic transition

The dashed graphs in Figure 1 demonstrate the dynamic adjustments. We restrict ourselves here on a few comments. The interested reader is invited to compare the second section of Table 2 with its first section.

As can be seen from panels a, b, e, f, and g in Figure 1, the dynamics of sectoral labor and unemployment rates barely change. The reason for this is that these variables are mainly determined by the search and matching dynamics, which are not affected by the shock (note that we have assumed that labor in both sectors falls by 14 points, as in the optimistic scenario). What changes is the output dynamics. As productivities recover more slowly, productions of industrial goods and tourism services rise more slowly, too, despite the fact that labor evolves as in the baseline scenario. As a result, after two years industrial production is at 95.3%, tourism service production at 89.3%, and GDP is at 93.8%, and the economy's full recovery takes much more time (roughly eight years; see panel i in Figure 1). Consequently, the debt-GDP dynamics are more pronounced (panel j). Interestingly, although the speed of adjustment of the tourism demand parameter remains unchanged, foreigners' tourism demand recovers more slowly, too, as can be seen in Table 2. Two years after the shock, it is still only at 89.5% of its pre-shock level. The reason is that during the first four years of transition, the relative price is higher, compared to the baseline scenario, and this dampens tourism demand. In the alternative scenario, where the industrial sector is hit much stronger than in the baseline scenario, economic recovery slows down considerably, and the two sectors' dynamics evolve more equally.

5 SENSITIVITY ANALYSIS

It is important to investigate how our results depend on the calibration. We therefore ask if and how our results are affected by a few important parameters which concern the international financial market and foreigners' tourism demand. We perform a sensitivity analysis with respect to the economy's access to the international financial market, with respect to the price elasticity of foreigners' tourism demand, and with respect to the speed of adjustment of the foreign tourism demand parameter D. All other parameters are set as in the baseline calibration.

5.1 Degree of financial openness

Aside from its adverse effects on supply and demand, the COVID shock also affected international financial markets, as financial conditions significantly tightened, and emerging market sovereign spreads have widened significantly (see IMF, 2020). We therefore briefly discuss the effects of different degrees of access to the international financial market by varying ϑ from 0.04, proxying almost unlimited access, to 0.4, which means limited access to financial markets, to 4, which proxies exclusion. The time paths of some key economic variables are shown in Figure 2. The solid line corresponds with the baseline economy $\vartheta = 0.04$, the short-dashed line with $\vartheta = 0.4$, and the long-dashed line with $\vartheta = 4$.[20]

[20] Note that by changing ϑ, the benchmark equilibrium changes, too.

Figure 2 - Sensitivity analysis with respect to financial openness

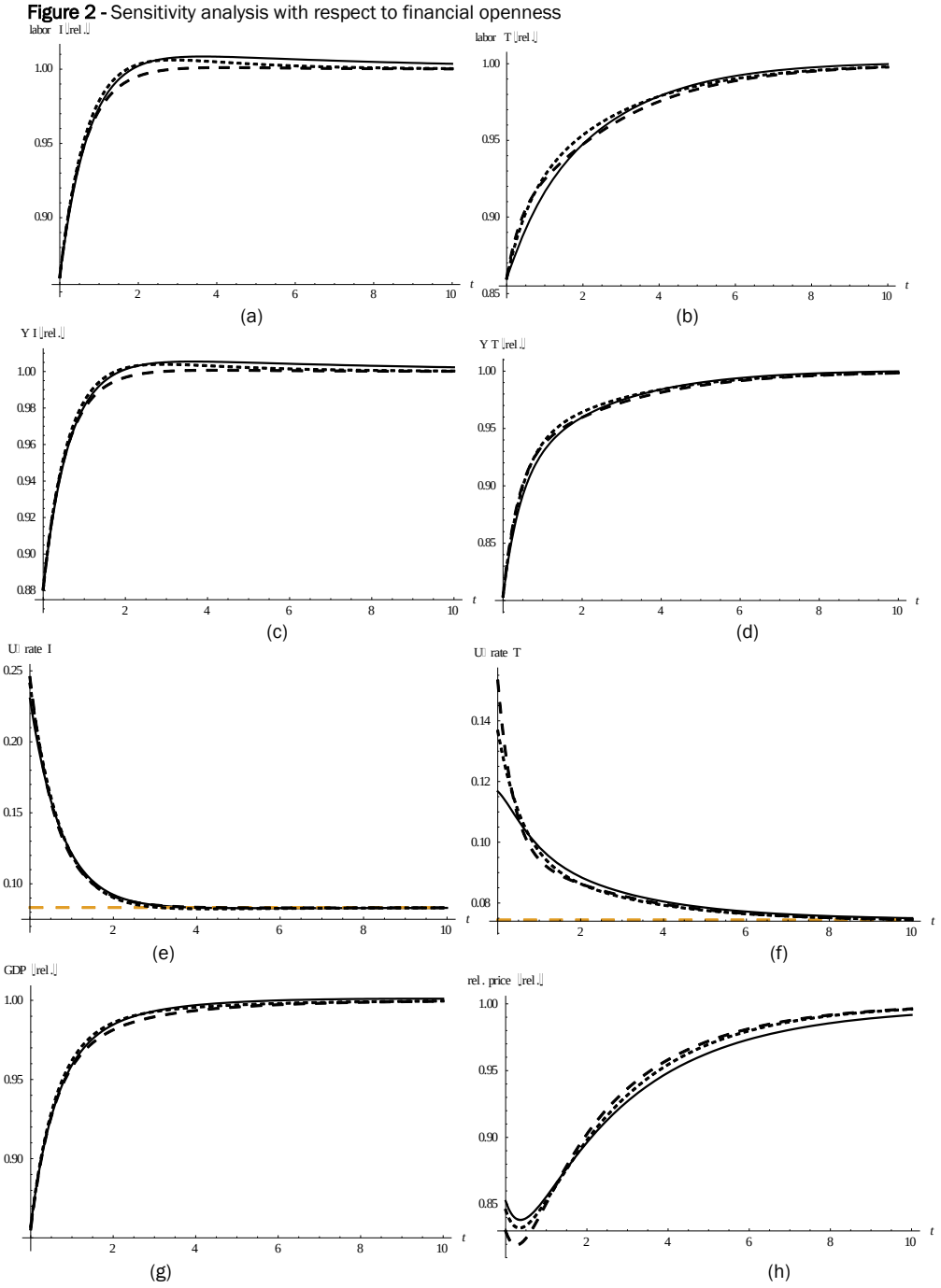


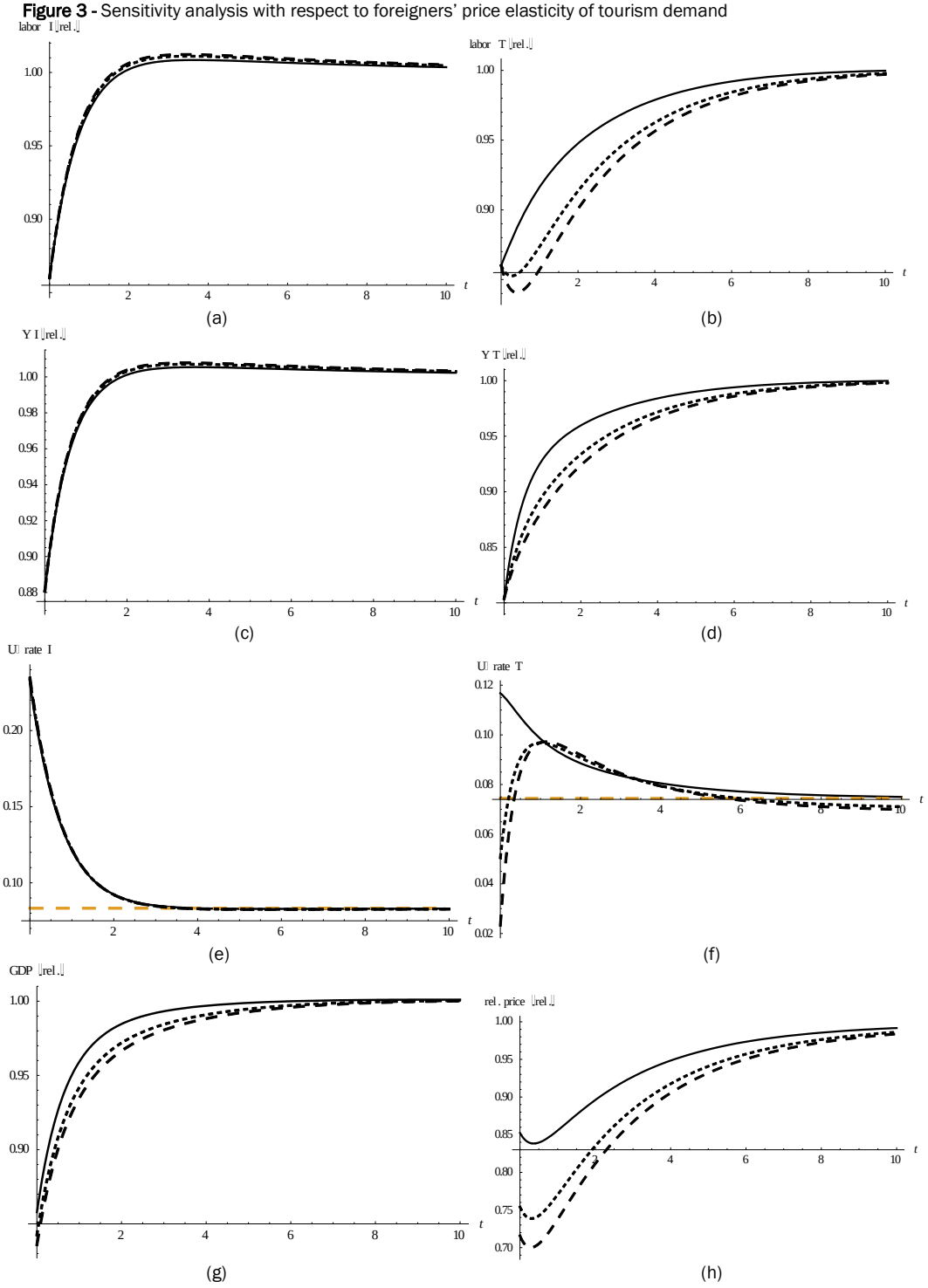
Figure 2 shows that the degree of financial openness does not matter much for sectoral labor and sectoral outputs. It matters, however, for unemployment. The unemployment rate in the industrial sector increases slightly when the degree of openness falls (see panel e), and the unemployment rate in the tourism sector increases substantially when the economy has restricted access to international financial markets. The reason for this can be found in the impact response of the marginal utility of wealth, which is the greater the smaller financial openness, as reduced openness implies larger interest rate responses to shocks affecting GDP. A higher marginal utility of wealth induces households to consume less goods and services and also less leisure, which, given employment, implies that they search more for jobs. This behavior results in a more pronounced effect on unemployment in the tourism industry than in the industrial sector. More search for jobs results in more matches, therefore labor in the tourism sector recovers faster than in the industrial sector (compare panels a and b in Figure 2). Figure 2 reveals that after roughly two years the differences in unemployment rates due to different degrees of financial openness tend to become marginal. We can summarize

that for the COVID shock financial openness matters most in the short run, and there mostly for unemployment.

5.2 Price elasticity of foreigners' tourism demand

Our second sensitivity analysis concerns the role of the price elasticity of foreigners' tourism demand, η_T, for the dynamics the COVID shock causes. For this purpose, we lower η_T from its benchmark value 1.75 (solid lines) to 1 (unit-elastic demand, short-dashed lines) and further to 0.85 (long-dashed lines), covering thus the range of empirically plausible price elasticities (see Lanza,Temple, and Urga (2003) and Garín-Muños (2007). Figure 3 shows the corresponding time paths.

Figure 3 - Sensitivity analysis with respect to foreigners' price elasticity of tourism demand



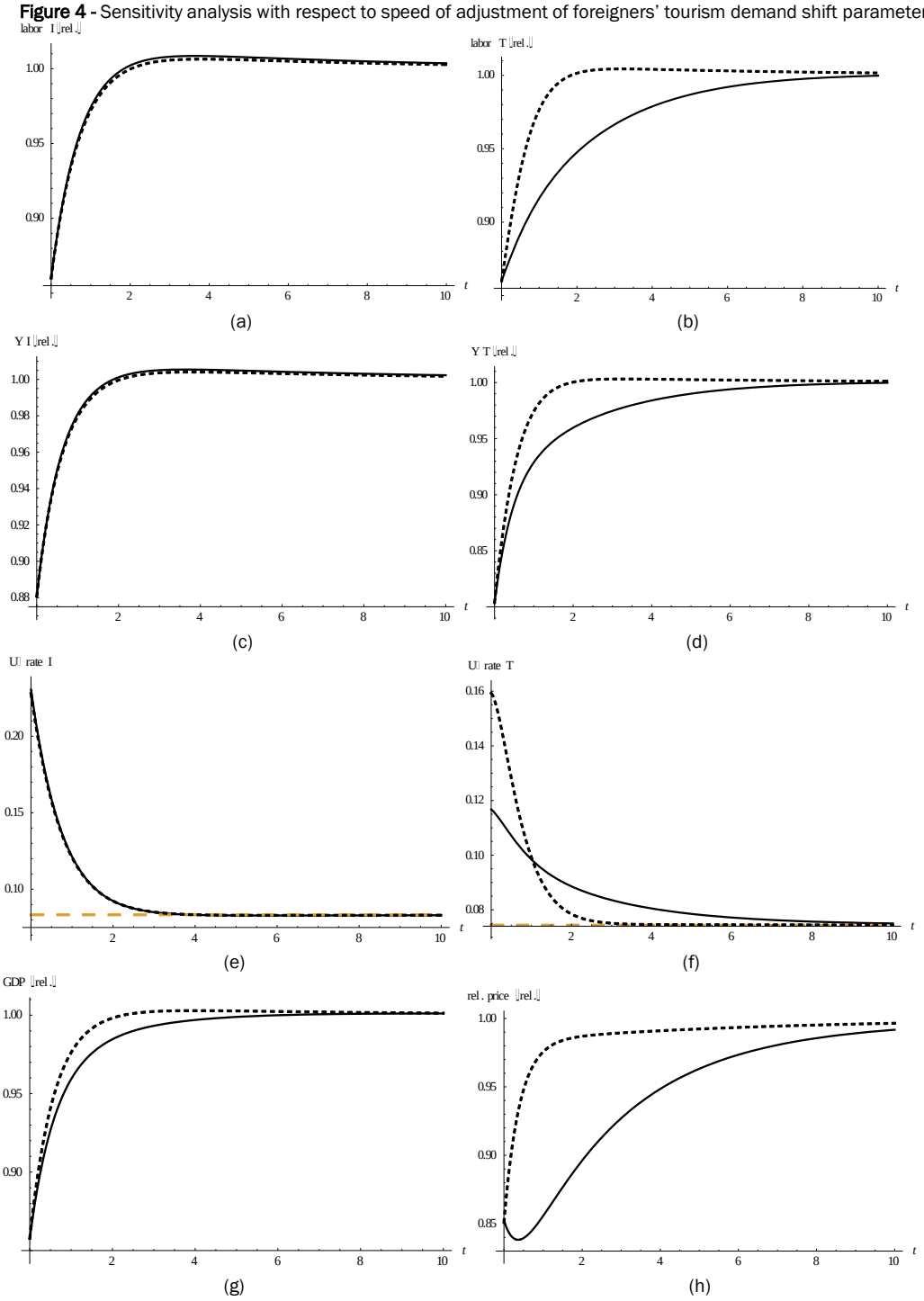
Interestingly, the dynamics in the industrial sector caused by the COVID shock are basically unaffected. Intuitively, the two labor markets are separated, so that there are no direct spillovers. However, the price elasticity matters a lot for the tourism sector, as can be seen in panels b, d, f, and h of Figure 3. The lower the price elasticity of foreigners' tourism demand, the larger the reduction in the relative price p has to be to restore equilibrium in the tourism market after the shock hit the economy. Compared to the benchmark scenario, where on impact the relative price drops to roughly 85% of its benchmark, in case of inelastic demand the price has to fall to roughly 71.5%, that is, has to fall roughly twice as much as in the benchmark scenario (see panel h). This has severe consequences for the tourism sector. Because the marginal value product of labor drastically falls, the bargained wage in the tourism sector falls a lot, too, substantially reducing the value of a job in the tourism sector. Therefore, households reduce search in the tourism industry a lot, resulting in a low sectoral unemployment rate (2.3%, see panel f). The outflows from the labor market (via job separation) in the tourism sector are larger than the inflows (via searching and matching), and employment actually reduces in the very first stage of transition (roughly the first quarter). From thereon, labor in the tourism industry starts to increase, and after two quarters it is back at its level it had immediately after the shock happened. Tourism production (see panel d), recovers the more slowly the smaller the price elasticity, because the price elasticity affects the sector's labor market dynamics. Therefore, GDP increases more gradually, too (panel g). Interestingly, the price elasticity does almost not matter for the overall reduction in foreigners' tourism demand, because the lower price elasticity is "offset" by a larger price decrease. We conclude that the COVID shock affects the tourism sector the stronger the smaller foreigners' price elasticity of demand.

5.3 Speed of adjustment of foreigners' tourism demand parameter

Our last sensitivity analysis concerns the role of the speed of adjustment δ_D of the shift parameter D in foreigners' tourism demand. To see what would happen if tourism demand would quickly recover, we increase δ_D from its plausible benchmark value 0.4 (solid lines) to 2.5 (dashed lines). Figure 4 shows the corresponding time paths.

As Figure 4 demonstrates, the overall effects of the COVID-19 shock barely depend on the speed of recovery of the demand shift parameter D in foreigners' tourism service demand. The dynamics in the industrial sector remain almost unaffected (see panels a, c, e), whereas of course the dynamics in the tourism industry change. A quick recovery of foreigners' tourism demand calls for fast price increases (see panel h), and this raises the marginal value product of labor in the tourism sector and so this sector's bargained wage, raising the value of a job in the tourism sector, inducing households to increase their search efforts there, which boosts the sectoral unemployment rate (see panel f). More search yields more matches, and therefore labor in the tourism sector and hence tourism production recover much faster (panels b and d). The faster relative price increase combined with quicker tourism production recovery leads to a more pronounced GDP upswing (panel g). The perhaps surprising result that the industrial sector's recovery is almost unaffected from tourism demand recovery and basically depends on the speed of its productivity adjustment but not on international tourism demand, is due to the fact that the relative price absorbs changes in the tourism sector.

Figure 4 - Sensitivity analysis with respect to speed of adjustment of foreigners' tourism demand shift parameter



6 CONCLUSIONS

In this paper we have analyzed the dynamic economic effects of the COVID-19 shock hitting a dependent small tourism dependent open economy comprising two sectors. For the sake of simplicity and by focusing on the shorter run, we abstracted from physical capital. Nonetheless, due to the model's complexity, analytical solutions are unavailable, and we resorted to numerical simulations to gain insights into the impact effects and the following dynamics. The numerical simulations where based on a reasonable calibration. We investigated a multiple shock, caused by the COVID pandemic. On the supply side, we reduced sectoral productivities by 3% in the industrial sector and by 10% in the tourism sector, reflecting the fact that the tourism sector was particularly hit by COVID-19, and labor by 14%, driving workers into unemployment, due

to firms' shut-downs and workers' infections. On the demand side, we assumed a huge drop in inbound tourism, that is, in foreigners' demand for domestically produced tourism services.

Our findings are: On impact, the relative price of domestically produced tourism services has to drop, because tourism demand falls by much more (by 1/3) than tourism production (roughly by 20%). As workers lose their jobs, sectoral unemployment rates shoot up, where the its increase in the industrial sector is particularly big. The current account turns into deficit, and due to the deep recession, the debt-GDP ratio increases by more than 8 percentage points. Due to the lower relative price (and, of course, due to travel restrictions), domestic residents substitute domestic tourism consumption for foreign tourism service consumption, that is, they spend their holidays "at home".

During the dynamic transition, caused by the shock, the economy recovers, where the tourism sector's recovery is much slower than the industrial sector's pickup. Indeed, the tourism sector needs roughly one decade to convert back to its pre-shock state, whereas the industrial sector has reached its pre-shock production after already two years. Interestingly, the different speed of the two sectors' recoveries does not depend on the tourism sector's larger initial productivity drop, but is caused by the immense drop in foreigners' demand for domestic tourism services. The tourism sector's slow recovery opens room for policy interventions, in particular policies that stimulate foreigners' tourism demand, e.g., improving tourists' confidence by safety concepts, advertising, or subsidies to the tourism industry.

We also performed sensitivity analysis with respect to the degree of the economy's access to the international financial market, with respect to foreigners' price elasticity of tourism demand, and with respect to the speed of recovery of foreigners' demand. We found that the degree of financial openness basically matters for unemployment, but does not strongly affect the economy's reaction to the COVID shock. The lower the price elasticity of foreigners' demand for domestic tourism services, the stronger the tourism industry suffers from the shock. The tourism sector's unemployment rate is strongly affected by price elasticity in the first phase of transition. In contrast, the industrial sectors dynamics is rarely affected by price elasticity. The same holds for a faster speed of recovery of foreigners' tourism demand. The industrial sector is barely affected, but the tourism sector will recover the quicker the faster the speed of adjustment of foreigners' tourism demand.

Feeling that the model nicely describes what economically happened in the very first months after the COVID-19 pandemic hit economies and what time path an economy dependent on international tourists will probably take in the near future, we shall conclude with some caveats. First, we have not modelled COVID infection dynamics. While this is an interesting topic, it is out of the scope of this paper, which is to provide a simple model to analyze the macroeconomic dynamics caused by COVID. Second, our results depend of course on the calibration. The bigger the share of the tourism sector in the economy, the more adversely the country is hit by the COVID shock. Third, we shall keep in mind that the unemployment rates implied by the model are not necessarily equal to the officially reported unemployment rates, due to differences in definitions. Moreover, in a lot of countries policies were implemented to reduce workers' layoffs (e.g., short-time allowances for firms which keep their workers), which resulted in mild increases in unemployment rates (e.g., in Germany). Fourth, introducing sticky wages would slow down the dynamics considerably (see Schubert and Turnovsky, 2018). It is questionable to what degree wages are sticky. In some countries they are very sticky, in others they are quite flexible. Fifth, to keep the model simple, we have abstracted from physical capital accumulation. Augmenting the model in this direction would be interesting, but would raise its complexity substantially. In particular, the dynamics will strongly depend on if capital is internationally traded or not. Sixth, the model could be augmented by introducing a government, whose policy instruments affect agents' decisions. The economic effects of different policies to fight the COVID crisis could thus be discussed. Extensions and applications of the model are thus evident.

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