

# Universal Health Insurance and Physician Specialty Choice: A Macroeconomic Analysis

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## Abstract

This paper studies the supply-side distortions in the medical service market caused by the cost-suppressing universal health insurance program. A general equilibrium two-sector model with endogenous specialty choice of heterogeneous physicians is presented. Physicians choose either to invest in the riskier but potentially more rewarding specialty or remain in the less risky and less rewarding specialty. We argue that because of the slow adjustment in physician supply due to the long medical training period, the short-run and the long-run effects of the implementation of cost-suppressing measures can be very different. In the short run, workers outside of the health sector are better off because of cheaper medical services and better health. As physicians respond to the cost-suppressing measure, there will be fewer physicians in the riskier specialty than in *laissez faire*. Also, physicians need to work more hours and quality of medical service decreases. As a result, the health level of the general public could be ambiguous.

JEL Classification: E13, I11, J24, J44.

Keywords: Specific Human Capital, Physician Specialty Choice, General Equilibrium Model, Universal Health Insurance, Misallocation in Talents.

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# 1 Introduction

*"It is my aspiration that health finally will be seen not as a blessing to be wished for, but as a human right to be fought for."*

- General Kofi Annan

Inequality in health, either across countries or within a country between the rich and the poor, has long been an important public policy issue. While poor health may be a direct result of poverty, low incomes can also be caused by poor health. Since the Universal Declaration of Human Rights in 1948, the right to adequate health care regardless of one's wealth status has been accepted as a common value around the world. Although not being the root of health inequalities, the health sector can still help provide equal access to health care. The World Health Organization thus has promoted universal health care for decades. By now lots of developed countries and NICs such as the U.K., France, Italy, Canada, Japan, Korea and Taiwan have already adopted universal health insurance (UHI) system for years. As for the U.S. where the health care and health insurance are mainly privately operated, increasing health insurance coverage rate is one of the major goals of the Obama administration.

UHI is designed and adopted with the aim to promote health equity and public welfare by providing *affordable* and universal healthcare services. However, due to population aging and cheaper prices (or out-of-pocket expenses) of medical services faced by patients, countries with UHI inevitably have to adopt cost control measures to maintain the sustainability of UHI. Generally speaking, the cost control measures can be categorized into consumer-side and medical service provider-side measures. The effects of those measures on the demand and the supply of health care could be very different, and some measures can even lead to distortions in resource allocation. We will come back to discuss this point later.

Different from other services, health care intrinsically involves uncertainty and asymmetric information. The nature of medical risk also varies across specialties. For example, physicians in surgery and emergency medicine get in medical disputes more easily compared to other specialties. Moreover, it usually takes more efforts and a longer training period for a medical student to become a matured physician in riskier and life-saving specialties. In a competitive market, the price of medical services (and physicians' income) would internalize the physicians' efforts as well as risks faced by physicians. Hence,

riskier specialties are rewarded by higher income and the choice of specialty can be boiled down to physicians' own interest and risk preference. However, if the cost control of UHI leads to a lower price of medical services without compensating the risk premium for physicians, the supply side of the medical service market can be distorted<sup>1</sup>. This paper thus studies the possible supply-side distortions caused by the UHI, with a special focus on the physician supply.

It is of particular note that the distortions in physician supply, if there is any, cannot be observed until a long period of time after the implementation of the cost-suppressing UHI. The reason is that governments around the world usually have tight regulations on the supply of physicians in order to assure the quality of medical services, and hence newly licensed specialists only constitute a very small proportion of the existing specialist stocks. Additionally, the training period of specialists is very long. It is very costly for a physician to switch his or her specialized field upon completion of the training. Because of the high switching cost, existing physicians in the most affected specialties are forced to work harder to accommodate the rising demand for health care under UHI. The healthcare quality may thus be lower due to longer working hours and a heavier workload. Alternatively, they can choose to opt out of UHI. Using biographical and income data on physicians in Tokyo, Ramseyer (2009) provided evidences to show that under the cost control of the universal healthcare system in Japan, the most talented physicians has disproportionately shifted to the “superfluous” medical sector – the cosmetic industry – to provide nonessential medical services that improve the beauty but not necessarily the health of the patients. The UHI, originally designed to improve the overall health of the people, *ends up creating unintended distortions in the physician supply and resulting in misallocation of talents and resources in the health sector.*

This paper studies the physician misallocation problem and inefficiencies in the healthcare sector caused by cost control measures under UHI. As UHI affects both the prices faced by health care demanders and suppliers, a general equilibrium framework is called for. We thus construct a two-sector general equilibrium model with endogenous physician specialty choice. More specifically, we follow the approach of the literature on educational investment and occupational choice à la Fender and Wang (2003) and Mino, Shimomura, and Wang (2005). Different from the two papers, our model contains two sectors, a goods sector and a health sector, and two groups of agents, workers

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<sup>1</sup>While the price suppression scheme in UHI affects all physicians regardless of risk premium in different specialties, a risk averse physician will switch towards low risk specialty when income is lower.

in the goods sector and physicians in the health sector. Physicians have to make specialty choice, deciding whether to invest in the more rewarding but riskier specialty. The workers in the goods sector simply purchase healthcare services from the health service market to improve their labor productivity. We show that the short-run and the long-run impacts of government's price-suppression intervention in the healthcare market could be very different. In the short run, the supply of physicians across specialties is fixed. The general public thus enjoys more medical services and better health at lower prices. However, physicians have to work extra hours in order to meet the excess demand in medical services. The resulting quality of health services will be lower. In the long run as physicians accommodate their specialty choices to the cost control and price-suppressing measures, there will be fewer physicians in riskier specialties, resulting in a shortage of physicians in those specialties. Physicians will be forced to work even more in order to accommodate the medical needs as the misallocation gets more severe. The quality of medical services further deteriorates. Finally, we show that physicians are worse off in both the short run and the long run as they are required to work more hours and earn less. For the general public, while they can consume more medical services in both the short run and the long run, the decrease in the quality of medical services could result in ambiguous effects on health levels. Hence, the cost-suppressing UHI could actually create a welfare burden to the society.

To the best of our knowledge, we are the first to adopt macroeconomic approach to examine the "side effects" resulting from cost control policies under UHI – an issue that is almost neglected in the discussion of universal health care. With a parsimonious theoretical framework, we are able to demonstrate the possible distortions and long-run consequences of a cost-suppressing universal health care system. We therefore see our paper of important policy implications, especially for countries at the onset of designing and moving toward a universal health care system.

## **Related Literature**

Research on issues related to health insurance usually focus on the demand side problems, studying topics such as how to increase the health insurance coverage rate, how health insurance affects precautionary saving motives, how health insurance affects labor market search behavior, and whether the health insurance is sustainable. Fang and Gavazza (2011) investigate how individual's medical expenditures are affected by the change in the US healthcare system. Zhao (2015) argues that the correlation between

health expenses and longevity provides a self-insurance so that rational agents would neither fully insure their uncertain health expenses nor fully annuitize their wealth. Hsu (2013) suggests that the precautionary motive of hedging against losing insurance can explain why US households covered by health insurance saved more than those without insurance coverage. Hansen, Hsu and Lee (2014) studies the impact of a Medicare buy-in using a general equilibrium life-cycle model. Chou, Liu and Hammitt (2003) show that the NHI in Taiwan reduced savings, especially for households with the smallest saving. Pashchenko and Porapakkarm (2013) find that the health insurance reform in the U.S. greatly decreases the number of the uninsured and generates welfare gains, while the welfare gains come mostly from redistributive measures embedded in the reform. Using an equilibrium labor market search model, Aizawa and Fang (2013) study the impact of the 2010 Affordable Care Act in the U.S. using micro data of the U.S. Hsu and Liao (2015) quantify the impact of population aging on the NHI program in Taiwan and provide estimates on the additional labor income tax required for the NHI to be sustainable.

The most related work to ours in terms of the issue studied but not methodology – the supply-side distortions brought by UHI – is Ramseyer (2009). Ramseyer (2009) shows that the Japanese price-suppressing NHI system has disproportionately shifted talented physicians to the cosmetic industry. Kondo and Shigeoka (2013) investigate the effects of the massive expansion of health insurance coverage on health care utilization in Japan, and find that health care utilization increased significantly after the completion of universal health insurance in 1961. Using the data from Taiwan, Cheng and Chiang (1997) also find similar results.

For the literature on physician supply and physician specialty choices, existing studies usually adopt the reduced form empirical approach. The literature typically centers on studying how the differential incomes across specialties affect medical school graduates' specialty choices, or investigating the causes to lifetime earning differentials across specialties (e.g. Nicholson 2002 and Bhattacharya 2005). As for the research on malpractice, most studies attend issues such as the supply and the pricing of malpractice insurance, the measure of the number of malpractice injuries and claims, and the effects of policy changes on malpractice reform in legal systems. As these two strands of the literature is not closely related to the current paper, we dismiss from further discussion of the literature.

The rest of the paper is organized as follows. In section 2, we briefly introduce the UHI system and the corresponding medical service market for selective countries. Section

3 describes the basic model, and Section 4 solves for the market equilibrium. In section 5, we analyze the short-run and the long-run equilibrium under government intervention. Section 6 concludes the paper.

## 2 Universal Health Insurance System

As mentioned in the previous section, with an aging population and lower fertility, health expenditures are surging. Governments around the world have adopted different strategies to control the growth of public health expenditures and maintain the quality of the health services while remaining cost efficient. We can summarize those strategies into two categories – the consumer-side cost control and the provider-side cost control strategies. The consumer-side cost control refers to strategies aimed at limiting the use of medical services while maintaining the quality of health services. Adopting a strict referral system, reducing hospital beds, promoting or restricting the use of generic drugs are strategies widely used in this category. On the contrary, provider-side cost control focuses on negotiating and bargaining with medical services providers, namely, hospitals and clinics, and sometimes pharmaceuticals suppliers. Physicians are often forced to receive lower remunerations under provider-side cost control measures.

In support of our motivation, we divide countries into two different groups according to their respective healthcare system. In the first group, health expenditures of UHI are mainly curbed by provider-side cost control measures. As the consumer prices of health care are low, demand for health care increases. This may bring physicians and UHI heavier workloads and higher health expenditure bills, and possibly lead to tighter provider-side cost control measures later. Our theory predicts a major distortion in physicians' allocation in this group. In the second group, countries either do not have universal health care or have UHI but suppress their health expenditures by using consumer-side cost control measures. Although the consumer prices of health care are kept low, the demand for health care is not increased because of higher implicit costs such as long waiting time. Hence, we do not expect a large distortion in physicians' allocation in this group. In the following, we provide a brief overview of the UHI systems and evidence for some selected countries by the type of cost control measures adopted.

## Provider-side Cost Control

### Taiwan

Taiwan has implemented its UHI scheme - the National Health Insurance (NHI) in 1995. All residents in Taiwan are required to register to the NHI system managed by the NHI Administration. Hospitals and clinics can choose whether to participate in the NHI.<sup>2</sup> Copayment is very low and the NHI in Taiwan are mainly financed by earmarked tax. Under the NHI, all the medical services are priced and paid according to a point system that was set before the implementation of the NHI. The NHI administration pays directly to participating hospitals and clinics according to the points of services provided, and hospitals and clinics then pay to their physicians and medical staff.

When the NHI was first implemented, one point valued one New Taiwan dollar (NTD). However, due to the soaring health expenditures, the NHI administration soon decided to introduce the global budget system with annual expenditure cap in 2001. The value of a point thus varies across years and is computed by dividing the total budget to the total points of medical services provided. Figure 1 shows that the value of a point has dropped sharply since the introduction of the global budget system. The point value has always been below one NTD since 2003. As the number of points assigned to each medical service is predetermined, the prices of medical services are discounted as a result.<sup>3</sup> Also, if a medical service provided is considered unnecessary, the points attached to the service will be erased. The physician who provided the service will not be paid, and a penalty will be imposed to the medical institution that the physician worked for. Meanwhile, the relationship between patients and physicians has deteriorated. According to Wu, Lai and Chen (2009), the incidences of criminal or civil court cases rising from medical disputes have increased by more than two times from 1991 to 2005. For physicians in the specialties dealing with more complicated and critical medical conditions, they face a higher chance of being involved in medical disputes. Liu (2011) reported that from 1994 to 2008, roughly 85 percent of cases of medical disputes closed with court statements of verdict were related to the major five specialties<sup>4</sup>. Hence,

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<sup>2</sup>Up to May 2016, the percentage of hospitals and clinics participating in the NHI accounts for 92.99% out of total hospitals and clinics in Taiwan. Data source: Ministry of Health and Welfare, Taiwan, R.O.C.

<sup>3</sup>Another evidence showing that the global budget system is indeed price-suppressing is the decreasing profits of hospitals. Major hospitals are experiencing declining profits or even negative profits from providing medical services, and have to make profits from non-medical related services.

<sup>4</sup>The five major specialties in Taiwan refer to internal medicine, surgery, pediatric medicine, obstetrics and gynecology and emergency medicine.

the risk of being involved in medical disputes for physicians in the five major specialties are much higher than physicians in other specialties. In Table 1, we observe that there is a large decline in physicians' distribution in the major five specialties over the period of 1991 to 2014. Both internal medicine and surgery have shrunk by more than 8 percentage point in distribution. Specialties with lower risks, such as family medicine, became more popular and constituted the largest increase in distribution. Plastic surgery, which is generally not covered by the NHI and hence suffers less from the price-suppressing system, shows increases in popularity even though the risk involved is potentially high. This indeed provides evidence to support the possible relationship between risks, cost control measures and misallocation of physicians – the topic that we are studying.

## Japan

Japan has achieved universal health care in 1961. Under Japan's universal healthcare system, citizens are mandated to enroll in one of the public health insurance programs. The National Health Insurance (NHI), the public health insurance that most Japanese enrolled in, is operated at municipality level. Depending on the age of the insured, the NHI allows enrollees to enjoy medical services at a low cost by paying insurance premiums plus copayments ranging from only 10 to 30 percent. In addition, individuals are entitled to an upper limit of medical expenses. Any expenditures above a preset limit will be paid by the insurers. One feature of the Japanese system is that the insured can receive medical services in any medical institution nationwide.

However, due to the increasing medical expenditures, the Health Insurance Bureau is managing to contain cost, especially on the provider side. Similar to the system in Taiwan, Japanese NHI runs a point system with one point equals to ten yens. Instead of changing the point value, Japanese Central Social Insurance Medical Council revises points assigned to each of the medical services every two years with a preset overall spending target. Other cost cutting measures, such as advising the use of cheaper drugs or generic drugs and guiding medical services from hospital beds to at-home care, are also employed. Besides, the Health Insurance Bureau is promoting regular physical checkups as they found that medical expenditures incurred are much lower for diseases spotted at the onset than that spotted at later stages.

According to Ramseyer (2010), physicians in Japan have been facing increasing risks in malpractice claims. Among all malpractice claims, 46.3 percent are surgery related. Obstetrics is also at high stakes and accounts for 15.5 percent of the total malprac-



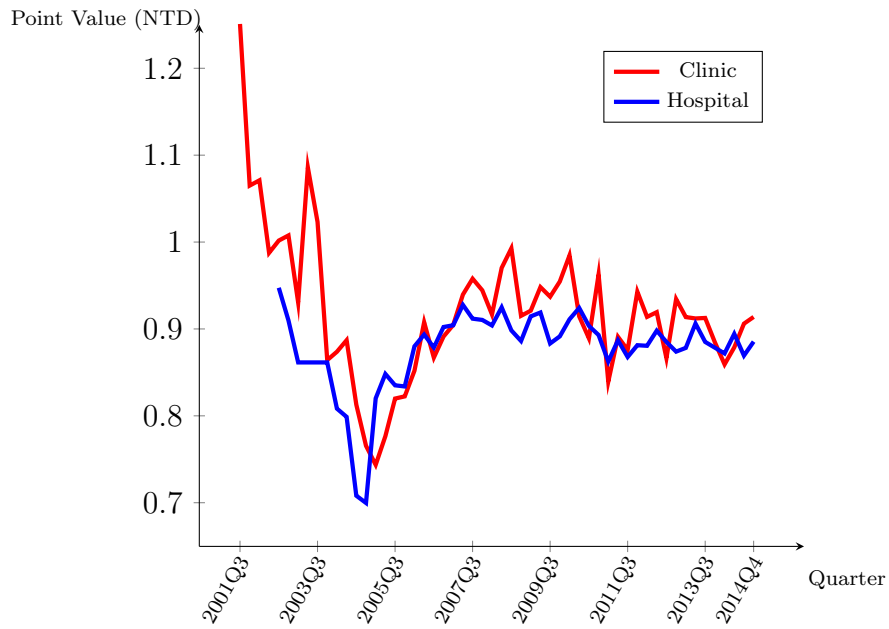


Figure 1: The Point Values in Taiwan, 2001Q3-2014Q4

Medical specialty	1991	2014	1991-2014
Major five specialties	68.65	51.62	-17.02
Internal medicine	32.41	23.57	-8.85
Surgery	17.46	9.33	-8.32
Pediatrics	7.28	8.63	1.36
Obstetrics and gynecology	11.32	5.90	-5.41
Emergency medicine*	-	4.19	-
Non major five specialties	31.35	48.38	17.02
Family medicine	3.53	8.80	5.27
Plastic surgery	0.39	1.20	0.82

Data source: Taiwan Medical Association.

\*Emergency medicine was not counted as a specialty until 1998.

Table 1: Distributions of physicians in percentage in Taiwan, 1991-2014

Year	Internal medicine	Surgery	Obstetrics and gynecology	Plastic and cosmetic surgery
1994	32.20	11.36	5.61	7.63
2014	24.48	7.54	4.34	8.04
Change in Distribution	-7.72	-3.82	-1.27	0.41

Data source: Ministry of Health, Labour and Welfare, Japan

Table 2: Distributions of physicians in percentage in Japan, 1994-2014

tice claims. As suggested by Ramseyer (2009), the NHI's provide-side cost control has disproportionately shifted talented physicians to the cosmetic industry. In Table 2 we show that internal medicine and surgery has the largest decline in physician distribution over the period of 1994 to 2014. The decreasing trend is also true for obstetrics and gynecology. Furthermore, plastic and cosmetic surgery has increased 0.41 percent over the same period. Although the increase seems to be small for a 20-year span, the total number of physicians in plastic and cosmetic surgery actually increased by more than 41 percent. The experience for Japan is consistent with that for Taiwan, and is supporting our argument that a provider-side price-suppressing UHI system is possible to lead to misallocation of physicians.

## Consumer-side Cost Control

### Italy

The National Health Service in Italy (Servizio Sanitario Nazionale) is regionally based, with the responsibility for health care shared by the central government, the regional governments and the autonomous provinces. The central government distributes tax revenue to every region, while the local governments have high levels of autonomy in determining the local health system and are responsible for the delivery of health services. Coverage is automatic and universal for all the citizens and legal foreign residents. While the visits for general practitioners and hospital stays are free, patients have to pay a copayment up to a ceiling for procedures and specialist visits.

Although Italy does not have a separate balance for its NHS, rising public debt has forced the Italian government to take measures to control its health expenditures. For example, in July 2011, the government introduced an additional copayment of 10 euros for each prescription. In addition, the Italian government has adopted several cost control measures and a lot of them are aimed at limiting the access of certain medical service. These include reducing the number of hospital beds, revising hospital and diagnostic

Year	Orthopaedics	Obstetrics and gynecology	Plastic surgery
2009	4.10	5.58	0.37
2013	3.93	5.04	0.97
Change in Distribution	-0.17	-0.54	0.61

Note: The data is obtained from Eurostat. Data on numbers of physicians by detailed medical specialty is not available prior to year 2009.

Table 3: Distributions of physicians in percentage in Italy, 2009-2013

fees, promoting generic drugs, and etc. Furthermore, the prices of reimbursable drugs are negotiated between the government and the manufacturers, and only the prices of non-reimbursable drugs are set by the market.

As suggested by Traina (2009), Italy has the highest number of physicians subject to malpractice-related criminal proceedings among European countries. Between 1996 and 2000, for cases filed related to medical malpractice, orthopaedics and traumatology were accountable for the highest number, followed by obstetrics/gynecology. Table 3 shows the changes in these specialties from 2009 to 2013. In a less than 5-year span, we observe that the two specialties – orthopaedics and obstetrics/gynecology – which suffer from the highest risk of malpractice have both experienced a decline in popularity. On the contrary, specialties such as plastic surgery have experienced increasing popularity during the same period. As we can see, the recent trend of physician supply in Italy, as well as that in other countries, warrants some worries. However, the changes in physician distribution are mild as the Italian government are suppressing cost not only from the provider side, but also the consumer side.

## France

The French universal health care system, running under statutory health insurance (SHI), provides universal and compulsory coverage to all residents. SHI is mainly financed by payroll taxes, and the public health expenditure amounts to 76-77 percent of total health expenditure in recent years. The healthcare costs are shared by coinsurance and copayment. Different from the case of Japan, the coinsurance rates vary across different types of care and drugs.

SHI has been in large deficits over the past 20 years, but the deficits of SHI have been fallen in recent years. This reversing trend in deficits can be attributed to a series of initiatives on tax and regulation in 2000s. Similar to the Italian case, most of the cost-

containing measures are on the consumer side. Major measures include reducing the number of acute-care hospital beds, removing many drugs from public reimbursement, promoting generic prescription and over-the-counter drugs, reducing test redundancy and official fees for self-employed radiologists biology labs. It is noteworthy that unlike Taiwan and Japan, global budgets are used only on the purchase of drugs and devices. We report in Table 4 the changes in physician distribution for some selected specialties during 2005-2014, and obviously that the changes in physician distribution are not as dramatic as that in Taiwan and Japan. Consistent with our theory, the cost suppression and regulations on the consumer side of health care do not seriously distort the distribution of physicians, and hence the talent allocation, in France.

Medical specialty	2005	2014	2005-2014
Generalist medical practitioners	49.29	46.38	-2.92
Specialist medical practitioners	50.71	53.62	2.92
General paediatricians	3.30	3.56	0.26
Psychiatrists	6.57	6.81	0.24
Medical group of specialists	23.36	24.81	1.45
Internal medicine	1.19	1.84	0.65
Cardiology	2.93	3.12	0.19
Neurology	0.88	1.08	0.20
Radiology	4.29	4.57	0.28
Occupational medicine	3.09	3.30	0.22
Surgical group of specialists	12.94	13.83	0.89
General surgery	2.45	2.21	-0.24
Plastic surgery	0.24	0.39	0.15
Orthopaedics	1.10	1.43	0.33
Urology	0.93	1.26	0.33

Note: The data is obtained from Eurostat. Data on numbers of physicians by detailed medical specialty is not available prior to year 2005.

Table 4: Distributions of physicians in percentage in France, 2005-2014

### 3 The Model

Time is discrete. The economy consists of two sectors, a goods sector which produces general consumption goods, and a medical service sector that provides medical service to improve health and labor productivity of workers in the goods sector. In each period, a unit measure of two-period lived agents is born. In the first period of life, the childhood, agents acquire skills if necessary. In the second period of life, the adulthood, they provide

labor and earn wages for consumption. Among each cohort, a fixed measure of  $1 - \alpha$  agents is born to be workers in the goods sector, while the remaining  $\alpha$  agents are born to be physicians and will work in the medical service sector when they turn adults.

### 3.1 The Goods Sector

In the goods sector, agents are homogeneous. There is no need for them to accumulate human capital in the childhood. Upon entering the adulthood, agents supply labor and divide their income into consumption and medical services. Agents in the goods sector maximize utility given by

$$\log(c)$$

with the budget constraint specified as

$$c + px = wl(h)$$

where  $c$  is consumption,  $p$  is the price of medical services,  $x$  is the quantity of medical services purchased,  $w$  is the wage rate in the goods sector, and  $l(h)$  is the agent's labor supply, which depends on the individual health level  $h$ , with  $l' > 0$ ,  $l'' < 0$ . The individual health level,  $h$ , is assumed to be formed through a production technology  $H$  which is increasing in the quantity of medical services acquired  $x$  and decreasing in the average labor hours of physicians,  $l_p$ . The production of  $h$  is given by

$$h = H(x, l_p)$$

As physicians provide more labor hours to accommodate more patients, the attention each patient obtained will be less. Moreover, the quality of medical services can also be lower because of tiredness. Hence, even with the same amount of medical services purchased (e.g. same number of visits for outpatient service), the medical service will be less effective in improving health when physicians are overworked. Hence,  $H$  is decreasing in  $l_p$ .

To simplify the analysis, the goods production technology is assumed to be linear in labor, i.e.,

$$Y = AL, \quad A > 0$$

where  $Y$  is the total output,  $A$  is the technology scaling factor, and  $L$  is the aggregate labor supply in the goods sector, respectively. In the next, we turn our focus to the medical service sector.

### 3.2 Medical Service Sector

In the medical service sector, physicians are heterogeneous in their talents, which is denoted by  $a$ . Assume that the talent distribution of physicians  $F(a)$  is stationary for each cohort over time, and  $F$  has a full support in  $[0, \bar{a}]$ . For simplicity, we assume that there are only two specialties, namely, the high-risk and the low-risk specialties. In the first period of their life, physicians make specialty choices and accumulate required skills. For the high-risk specialty, the cost of acquiring required skills is higher, and more talented physicians are able to provide more high-risk medical services. Besides, due to the risky nature of the medical services provided, there is a higher chance for the high-risk specialists to be involved in medical disputes. On the contrary, for the low-risk specialty, there are zero cost of acquiring required skills, and the chance of being involved in a medical dispute is zero. Moreover, a physician's talent does not affect his or her productivity in providing low-risk medical services<sup>5</sup>. Denote  $I_H$  as an indicator function such that

$$I_H = \begin{cases} 1, & \text{if the physician chooses the high-risk specialty.} \\ 0, & \text{otherwise.} \end{cases}$$

Let  $z_H$  be a binary random variable for specialists in the high-risk specialty such that  $z_H = 1$  if a medical dispute occurs,  $z_H = 0$  if nothing happens, with probabilities  $Pr(z_H = 1) = q$  and  $Pr(z_H = 0) = 1 - q$ . An occurrence of medical dispute will result in  $\lambda_H$  of loss for the high-risk specialist. Denote  $\xi_H$  as the cost of acquiring the skills for performing high-risk medical services. For a physician with talent  $a$  choosing to specialize in the high-risk field, he needs to pay a cost  $\xi_H$  in the childhood to acquire the required skills. In the adulthood, he supplies  $l_H$  unit of labor and earn a wage of  $w_H(a)$ . A physician thus maximizes the following expected utility

$$E[\beta(\log(c) - v(l)) - I_H \xi_H]$$

where  $\beta$  is the time discount factor with  $0 < \beta < 1$ ,  $v(l)$  is the disutility in labor with  $v' > 0$  and  $v'' < 0$ . The budget constraint for a physician with talent  $a$  is thus given by

$$c = I_H (w_H(a)l_H - z_H \lambda_H) + (1 - I_H)w_L l_L$$

Assume that the aggregate medical service,  $X$ , is produced with the following CES

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<sup>5</sup>While these assumptions might not be realistic, it does not affect the results that we are going to obtain and greatly simplified the analysis. One can think that the cost of acquiring required skills for the low-risk specialty is normalized to zero (relative to that for the high-risk specialty). Also, the low-risk field are less talents intensive.

production function:

$$X = (bX_H^\kappa + (1 - b)X_L^\kappa)^{1/\kappa}, \quad \kappa < 0 \quad (1)$$

where  $X_H$  and  $X_L$  are the aggregate high-risk and low-risk medical services, respectively. We assume that the two types of medical services are complements to each other, i.e.  $\kappa < 0$ .<sup>6</sup> The production technologies for the high-risk and the low-risk medical service are given by

$$\begin{aligned} X_H &= \int_{i \in \{i: I_H(a_i)=1\}} B_H l_H a_i^\gamma di \\ X_L &= \int_{i \in \{i: I_H(a_i)=0\}} B_L l_L di \end{aligned} \quad (2)$$

where  $B_H$  and  $B_L$  are the technology scaling factors of producing the high- and the low-risk medical services, respectively. Similar to the goods sector production technology, the production for both the high- and low-risk medical services are linear in labor. However, the productivity of the high-risk medical services also depends on physicians talents: the more talented the physician is, the more productive he is in providing high-risk medical services, with  $0 < \gamma < 1$ .

Finally, we assume that the medical service markets are competitive. Without loss of generality, we assume that there exists a representative profit maximizing hospital that supplies the final medical services  $X$  to the workers in the goods sector. The hospital operates the final medical service production technology (1) by buying high- and low-risk medical services from physicians.<sup>7</sup> The hospital's problem is thus given by

$$\max_{X, X_H, X_L} pX - p_H X_H - p_L X_L$$

subject to the production technologies (1) and (2), and  $p$ ,  $p_H$  and  $p_L$  are the prices of the final, the high- and the low-risk medical services, respectively. Since all the three medical service markets are competitive, the prices are determined in the equilibrium and taken as given by the hospital. This completes the description of the model.

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<sup>6</sup>A good healthcare system requires the cooperation of general practitioners (low-risk) and specialists (high-risk) as well as other medical personnel, such as nurses and caregivers. Therefore, it is straightforward to assume that the high-risk and the low-risk medical services are complements in improving an individual's health.

<sup>7</sup>One can also think that the hospital hires physicians and pays them with the competitive wages according to the medical services physicians provide.

## 4 Optimization and Equilibrium

To proceed with the analysis, we give specific forms to the environment that we have described in the previous section. Assume that the labor supply equation is given by

$$l(h) = \tilde{l}(1 - e^{-h}), \quad \tilde{l} > 0 \quad (3)$$

i.e., the labor supply of a worker in the goods sector increases as his health condition  $h$  improves, with  $\tilde{l}$  as the maximum labor he can supply. Let  $\bar{l}_p$  be the normal working hours and  $l_p$  be the actual working hours of physicians, respectively. The health production function is assumed to take the following form

$$h = H(x, l_p) = (1 - \tau(l_p))x \quad (4)$$

where  $\tau(l_p)$  is the quality discount function of the medical services purchased. Assume that  $\tau'(l_p) \geq 0$ ,  $\tau(l_p \leq \bar{l}_p) = 0$  and  $\lim_{l_p \rightarrow \infty} \tau(l_p) = 1$ . That is, the quality of the medical service depends on the working hours of physicians. If physicians are overworked, the quality of the medical services provided deteriorates. In case of no confusion, we will write  $\tau(l_p)$  as  $\tau_{l_p}$  for simplicity in the rest of the paper.

### 4.1 The Demand for Medical Services

The individual demand for the final medical service is determined by the first order condition of workers in the goods sector, which is given by

$$p = wl'(h)H_x(x, \bar{l}_p) \quad (5)$$

Since the goods production technology is linear in labor, the wage rate in the goods sector is  $w = A$ . By substituting (3) and (4) into (5), equation (5) becomes

$$p = A\tilde{l}(1 - \tau_{l_p})e^{-(1-\tau_{l_p})x} \quad (6)$$

The aggregate demand for the final medical service is simply the aggregation of the individual medical service demanded. As workers in the goods sector are homogeneous, we have  $X = (1 - \alpha)x$ . The aggregate demand for the final medical service can thus be written as

$$p = A\tilde{l}(1 - \tau_{l_p})e^{-(1-\tau_{l_p})X/(1-\alpha)} \quad (7)$$



## 4.2 The Supply of Medical Services

The supply of medical service is given by the production technologies in equation (1) and (2). The relative demand for the high- and the low-risk medical services is determined in the hospital's profit maximizing problem, while the supply of the high- and the low-risk medical services is directly linked to the physicians' specialty choice problem. Below we elaborate how we solve the two problems to determine the supply of the final medical service.

### 4.2.1 The Hospital's Optimization

The first-order conditions for the profit maximizing hospital are given by

$$\begin{aligned} p_H &= pbX^{1-\kappa}X_H^{\kappa-1} \\ p_L &= p(1-b)X^{1-\kappa}X_L^{\kappa-1} \end{aligned}$$

Hence, the relative quantity of the high- and the low-risk medical services depends on the relative price and is given by

$$\frac{X_H}{X_L} = \left[ \frac{b}{1-b} \frac{p_L}{p_H} \right]^{1/(1-\kappa)} \quad (8)$$

In an equilibrium, the competitive hospital earns zero profit. The zero profit condition is given by

$$p^{1-\kappa} = p_H^{\frac{-\kappa}{1-\kappa}} b^{\frac{1}{1-\kappa}} + p_L^{\frac{-\kappa}{1-\kappa}} (1-b)^{\frac{1}{1-\kappa}} \quad (9)$$

It is easy to understand equation (8) and (9). When the price of the final medical service  $p$  is higher, prices for different specific medical services are higher. Also, when there are more physicians in the low-risk specialty, the price for the low-risk medical services will be relatively lower than that for the high-risk one.

### 4.2.2 Physicians' Optimization

The allocation of physicians across the high- and the low-risk specialties is being determined in the physician's maximization problem. In the first period of life, physicians make specialty choices according to their talent  $a$ . A physician with talent  $a$  will choose to become a low-risk specialist if and only if

$$\beta[q \log(w_H(a)l_H - \lambda_H) + (1-q) \log(w_H(a)l_H) - v(l_H)] - \xi_H < \beta[\log(w_L l_L) - v(l_L)] \quad (10)$$

Examine the above equation. Since the left-hand-side (LHS) is increasing in  $a$  and the right-hand-side (RHS) is constant in  $a$ , we can find a critical  $a^*$  such that a physician with talent  $a^*$  is indifferent between the two specialties. In Lemma 1 in Section 4.3, we formally derive the conditions to guarantee the existence and the uniqueness of  $a^*$ .

Under  $a^*$ , a physician with talent  $a^*$  is indifferent between the high- and the low-risk professions. Equation (10) is thus held with equality:

$$\left(\frac{w_H(a^*)l_H}{w_L l_L}\right) \left(\frac{w_H(a^*)l_H - \lambda_H}{w_H(a^*)l_H}\right)^q = e^{\frac{\xi_H}{\beta} + v(l_H) - v(l_L)}$$

Suppose that physicians all work with normal hours, i.e.  $l_H = l_L = \bar{l}_p$ . The equation above becomes

$$\left(\frac{w_H(a^*)}{w_L}\right) \left(1 - \frac{\lambda_H}{w_H(a^*)\bar{l}_p}\right)^q = e^{\frac{\xi_H}{\beta}} \quad (11)$$

By substituting  $a^*$  and the production technologies (2) into equation (8), we arrive at an equation which connects the allocation of physicians according to their talents and the relative prices:

$$\frac{B_H \int_{a^*}^{\bar{a}} a^\gamma dF(a)}{B_L F(a^*)} = \left[\frac{b}{1-b} \frac{p_L}{p_H}\right]^{1/(1-\kappa)} \quad (12)$$

Moreover, because the technologies for both the high- and the low-risk medical services are linear in labor, wages are simply given by

$$w_H(a) = p_H B_H a^\gamma \quad (13)$$

$$w_L = p_L B_L \quad (14)$$

We now proceed to the discussion of the equilibrium.

### 4.3 Equilibrium

**Definition 1. (*Competitive Equilibrium*)** *Given the talent distribution of physicians  $F(a)$ , a competitive equilibrium in the economy of the model consists of physicians' specialty choice decisions, the goods sector workers' consumption and health investment decisions, the competitive hospital's profit maximization decision, the prices of the high- and low-risk medical services and the final medical service  $\{p_H, p_L, p\}$ , and wage rates in the goods sector and the medical service sector  $\{w, w_H(a), w_L\}$  such that:*

1. *Given the price of the final medical service  $p$  and wage rates  $\{w, w_H(a), w_L\}$ , the goods sector workers and physicians make consumption, health investments and specialty choice decisions to maximize lifetime utility;*

2. Given the prices of the high- and low-risk medical services and the final medical service  $\{p_H, p_L, p\}$ , the competitive hospital operates the final medical service production technology in (1) and hires physicians of the high- and the low-risk specialties to maximize profits;
3. The goods market, the markets for the high- and the low-risk medical services, the final medical service market, the labor markets for the goods sector workers and the high- and the low-risk specialists all clear.

To determine the equilibrium  $a^*$ , we substitute the price equation (9) into the physician allocation equation (11). By doing so, we have another equation which relates the relative price of different medical services  $p_H/p_L$  and the allocation of physicians  $a^*$ :

$$a^{*\gamma} \left( 1 - \frac{1}{p} \left[ b^{1/(1-\kappa)} + \left( \frac{p_L}{p_H} \right)^{-\kappa/(1-\kappa)} (1-b)^{1/(1-\kappa)} \right]^{- (1-\kappa)/\kappa} \frac{\lambda_H}{B_H a^{*\gamma} \bar{l}_p} \right)^q = \frac{p_L B_L}{p_H B_H} e^{\frac{\xi_H}{\beta}} \quad (15)$$

From the above equation (15), we derive the following lemma which guarantees the existence and the uniqueness for an interior solution of  $a^*$ .

**Lemma 1.** *There exists a unique solution for  $a^*$  if  $\frac{p B_H \bar{a}^\gamma \bar{l}_p}{b^{-1/\kappa} \lambda_H} > 1$ . Furthermore,  $a^*$  is decreasing in  $p$ , and approaches a constant  $C > 0$  when (i)  $p$  goes to infinity, (ii)  $q = 0$ , or (iii)  $\lambda_H = 0$ .*

*Proof.* See the Appendix. □

Lemma 1 simply states that  $a^*$  is decreasing in price  $p$ . This result can be easily understood. As the price of the final medical service increases without bound, the income effect associated with a higher price makes the loss from a medical dispute negligible relative to physicians' income. As a result, more physicians will choose to become high-risk specialists as they are more willing to take risks and  $a^*$  will decrease. We can also observe that when (1)  $p$  goes to infinity, (2) the probability of a medical dispute to happen is zero ( $q = 0$ ), or (3) there is no loss incurred for specialists in the high-risk profession when a medical dispute occurs ( $\lambda_H = 0$ ), high-risk specialists are no longer at stake. To make specialty choice decisions, physicians now simply compare the earnings in the low-risk specialty with the earnings they can get if they become high-risk specialists less the required training cost in utility. If they are better off in the later case, they will choose to enter the high-risk specialty.

In Lemma 2, we derive a result that is important in ensuring the supply curve of the final medical service to be positively-sloped.

**Lemma 2.** *Let the optimal allocation of physicians be the talent allocation that maximizes total output of the final medical services. Denote the cutoff in talent under the optimal allocation as  $a^o$ . Then, the threshold talent  $a^*$  under any competitive equilibrium, if exists, always satisfies the inequality  $a^o \leq C \leq a^*$ , with the first equality holds if and only if the cost of training  $\xi_H$  is zero and the second equality holds if and only if one of the three conditions in Lemma 1 holds.*

*Proof.* See the Appendix. □

That is, the optimal allocation of physicians can be reached only when (1) the training cost for the high-risk specialty is zero, and when (2) high-risk specialists incur no loss when medical disputes happen or the probability of a medical dispute is zero.

By substituting the equilibrium  $a^*$  into equations (1) and (2), we obtain the supply of the final medical service, which is given by

$$X = \bar{l}_p \alpha \left\{ b \left[ B_H \int_{a^*}^{\bar{a}} a^\gamma dF(a) \right]^\kappa + (1 - b) [B_L F(a^*)]^\kappa \right\}^{1/\kappa} \quad (16)$$

Lemma 1 and Lemma 2 together guarantee that the supply curve for the final medical service is positively-sloped. The economics behind this result is simple. When the cost of accumulating human capital is positive, the talent allocation of physicians is distorted from the allocation that maximizes the total output. With a similar rationale, when it is relatively more costly for physicians to accumulate required skills to become a high-risk specialist, the allocation of physicians to the high-risk specialty will be lower than that under the optimal case. Hence, an increase in the price of the final medical services will lead to more physicians choosing the high-risk specialty, pushing the physician allocation towards the optimal case. The output of the total final medical service increases as a result, and vice versa.

Figure 2 plots the demand and the supply curves of the final medical services given by equations (7) and (16). The equilibrium price of the final medical services can thus be solved using the two equations. Denote  $X^E$  and  $p^E$  the equilibrium quantity and price of the final medical services and  $X^C$  the corresponding quantity supplied when  $a = C$ , respectively. As shown in Lemma 2,  $a^o \leq C \leq a^*$  and hence  $X^O \geq X^C \geq X^*$ . Figure 2 shows the case when  $q > 0$ ,  $\lambda_H > 0$  and  $\xi_H > 0$ .

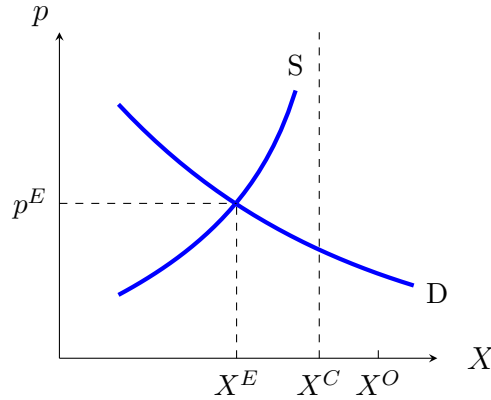


Figure 2: The supply and the demand in the final medical service market.

## 5 Government Intervention

In this section, we analyze the consequences of government intervention in the medical service market. UHI lowers the price of medical service paid by consumers and inevitably creates a wedge between the price paid by consumers and the price received by medical service providers. The cheaper consumer price of medical service may lead to an increase in the demand for health care. If the government adopts cost suppression measures on the provider side, the price of medical service which physicians receive is possible to be reduced. The cost containing measures and the price negotiation process vary across UHI systems and countries. Instead of focusing on how the UHI is implemented and the price is negotiated for a specific country, which is out of the scope of this paper, we simply study the impacts and the consequences of a price regulation on the health sector as well as the welfare of workers in the economy. Below, we consider a simple case where the government sets a price ceiling in the medical service market, and there is no price wedge between providers and consumers. While this is not a realistic consideration of how UHI is implemented, it captures the idea that we are presenting. We leave in the Appendix a more complicated version with provider-side cost control and price wedge between consumers and providers. All results and implications in this section hold through.

Before proceeding, we define the concepts of short run as the situation that physicians cannot adjust their professions in response to the policy change and are locked in their specialty choice, and long run as the case where physicians can freely adjust their specialty choice to the new policy. One could think that in the long run, new generations of medical students choose their specialties according to the new environment and grad-

ually replace the old generations. We use the superscript  $E$  to denote the equilibrium values under the competitive equilibrium without intervention, and the superscripts  $SR$  and  $LR$  to denote the short-run and the long-run equilibrium values after government intervention.

Consider the government regulates the final medical service market by forcing the price,  $p$ , down. Let the new price be  $\bar{p} < p^E$ . We can easily see that the quantity demanded for the final medical service goes up from equation (7), resulting in an excess demand for the final medical services. Given that the physicians already work with normal hours before the intervention, physicians now have to work extra hours in order to fulfill the demand, and hence  $l_p > \bar{l}_p$ . As a result, the medical sector is forced to supply the exact quantity of the final medical services demanded by the patients under the regulated price  $\bar{p}$ . While this may not be a standard assumption in the economics literature, it is a very reasonable one in the medical sector. When patients are packed in the hospitals or clinics waiting for medical care and consultation, physicians are very likely to be forced to work extra hours.<sup>8</sup> Below we make a simple assumption where all physicians' working hours increase uniformly in order to meet the extra demand. This is a parsimonious assumption as the high-risk specialty is affected more severely. It is expected that the effects would be larger if we relax this assumption.

## 5.1 Uniform increases in physicians' working hours

Suppose that all physicians increase their working hours uniformly to fulfill the extra demand for the final medical service. Denote  $l_p^{SR}$  and  $l_p^{LR}$  as the new working hours of physicians in the short run and the long run, respectively.

**Short-run Impacts** In the short run, physicians cannot switch their specialties. Hence, the threshold talent,  $a^*$ , is still the same as the  $a^{*E}$  which is given by equation (12) and (15). In order to fulfill the increases in the quantity demanded, physicians are forced to supply more labor, with  $l_p^{SR} > \bar{l}_p$ . The quantity supplied move along the demand curve as shown in Figure 3 (left panel)<sup>9</sup>. The demand for the final medical service is the same as the one in equation (7). The supply of the final medical service in equation (16) is

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<sup>8</sup>Alternatively, physicians could also manage to reduce consulting time for each patient and provide medical services within the normal working hours. In either case, physicians' workload increases and the quality of medical services decreases as a result.

<sup>9</sup>We refer the immediate effect as the change before the quality of medical service decreases.

now given by

$$X^{SR} = l_p^{SR} \alpha \left\{ b \left[ B_H \int_{a^{*E}}^{\bar{a}} a^\gamma dF(a) \right]^\kappa + (1-b) [B_L F(a^{*E})]^\kappa \right\}^{1/\kappa} \quad (17)$$

Notice that as working hours of physicians increase above the normal hours, the quality of the final medical services deteriorates by  $\tau_{l_p^{SR}}$ , and the demand for the final medical services will fall. We can solve the equilibrium  $l_p^{SR}$  easily from the demand and the new supply equations. However, we would like to further investigate how such price-suppressing policy affects the general public in the goods sector. While it is straightforward to think that such policy is beneficial to the goods sector workers in the short run because they now enjoy cheaper and more final medical services, the decreases in the quality of medical services provides a counteracting force. The right panel of Figure 3 plots the equilibrium in the short run, and Proposition 1 provides the condition for the workers in the goods sector to be better off in the short run.

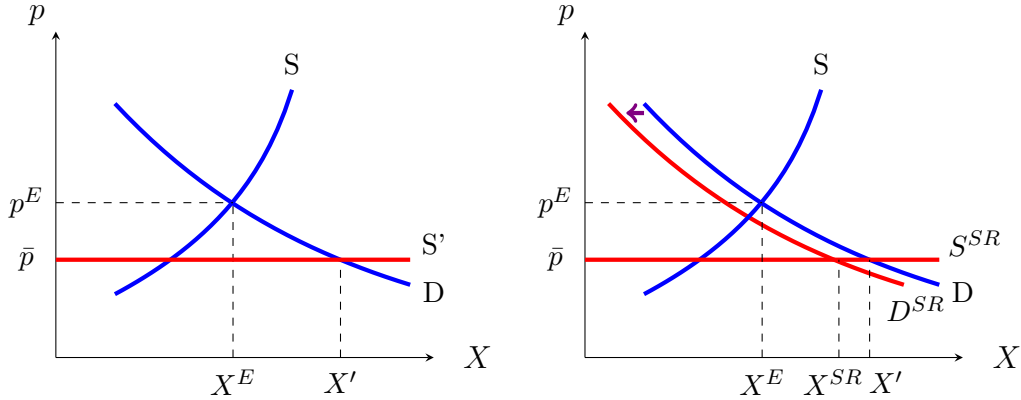


Figure 3: Immediate effects (left) and the short-run effects (right) when the government suppresses the price of the final medical services.

**Proposition 1.** *Let  $\tau$  be the discounted quality of medical service in the short run. Suppose that all physicians are forced to increase their working hours uniformly in order to fulfill the excess demand for the final medical services. In the short run, agents in the goods sector are better off if and only if  $p > p_\tau$ , where  $p_\tau \equiv \bar{p}/(1 - \tau)$ .*

*Proof.* See the Appendix. □

Proposition 1 is easy to understand. Let  $p_\tau \equiv \bar{p}/(1 - \tau)$  be the quality-adjusted price of the final medical service. While the government's cost-suppressing policy lowers the

price directly, the decrease in the quality of the final medical services acts as an offsetting force which raises the quality-adjusted price. If the benefits from the price-suppressing measure is larger than the deterioration in the quality of the final medical services, the quality-adjusted price decreases, and the goods sector workers will be benefited from such intervention. The welfare in the goods sector increases as a results in the short run.

With regard to the medical sector, it is clear that physicians suffer from longer working hours. However, the welfare of physicians may still increase if physicians' income increases. Since physicians are locked in their specialty choices in the short run, from equations (13)-(14) we can see that wages for the high- and the low-risk specialists are proportional to the prices of the specific medical services, and from equation (17) the working hours are proportional to the total quantity of the final medical services with  $a^*$  held fixed. The result is summarized in the following proposition.

**Proposition 2.** *Suppose that the equilibrium price of the final medical services is  $1 + \log p^E < \log(A\tilde{I})$ . Then, all physicians are worse off in the short run with falling income and rising working hours.*

*Proof.* See the Appendix. □

Notice that the condition in Proposition 2 is simply equivalent to the quality-adjusted price elasticity of demand being inelastic. When the demand is inelastic, total revenue earned in the medical service sector decreases. Hence, physicians are worse off by working for longer hours but earning less. While we have derived the condition in Proposition 2 when physicians are worse off. There are two reasons such that this condition should always satisfied in reality. First, if physicians are better off by increasing labor hours, they would have endogenously increase their labor supply before government intervention and normal working hours  $\bar{l}_p$  should increase. Second, as the goal of government is to reduce medical expenditure through provider side,  $\bar{p}$  will be set such that income of physicians always decrease.

**Long-run Equilibrium** In the long run, physicians are able to adjust their specialty in response to the policy change. This can also be interpreted as the case where new cohorts of physicians enter the market and optimally choose their specialty according to the market situation. Denote  $l_p^{LR}$  and  $a^{*LR}$  as physicians' new working hours and the new cutoff in talents. Equations (12), (15) and (7) becomes



$$\frac{B_H \int_{a^*LR}^{\bar{a}} a^\gamma dF(a)}{B_L F(a^*LR)} = \left[ \frac{b}{1-b} \frac{p_L}{p_H} \right]^{1/(1-\kappa)} \quad (18)$$

$$a^*LR^\gamma \left( 1 - \frac{1}{\bar{p}} \left[ b^{1/(1-\kappa)} + \left( \frac{p_L}{p_H} \right)^{-\kappa/(1-\kappa)} (1-b)^{1/(1-\kappa)} \right]^{-\kappa/(1-\kappa)} \frac{\lambda_H}{B_H a^*LR^\gamma l_p^{LR}} \right)^q = \frac{p_L B_L}{p_H B_H} e^{\frac{\xi_H}{\beta}} \quad (19)$$

$$\bar{p} = A\tilde{l}(1 - \tau_{l_p^{LR}}) e^{-(1-\tau_{l_p^{LR}})X^{LR}/(1-\alpha)} \quad (20)$$

respectively, with

$$X^{LR} = l_p^{LR} \alpha \left\{ b \left[ B_H \int_{a^*LR}^{\bar{a}} a^\gamma dF(a) \right]^\kappa + (1-b) [B_L F(a^*LR)]^\kappa \right\}^{1/\kappa} \quad (21)$$

Note that equations (18) and (19) are exactly the same as equations (12) and (15) except that  $p^E \bar{l}_p$  is replaced by  $\bar{p} l_p^{LR}$ . Hence, if  $\bar{p} l_p^{LR} < p^E \bar{l}_p$ , then  $a^*$  will increase according to Lemma 1. Similar to the short-run case, the condition is likely to be satisfied in reality. The decrease in the price results in lower total revenue for the medical service sector and hence, lower income of physicians. Recall that the main reason leading to the negative relationship between  $p$  and  $a^*$  is that when the price of the final medical services is higher, physicians earn more, and the income effects will encourage physicians to take more risks. Hence, if physicians earn less due to the price-suppressing policy, more physicians will prefer to work for the low-risk specialty, resulting in a higher  $a^*$ , i.e.  $a^*LR > a^*E$ . Figure 4 illustrates the long-run equilibrium for the final medical service market after the government implements the price-suppressing policy. In the left panel, the quantity supplied of the final medical services moves along the supply curve to  $X_1$  as physicians adjust their specialty choices. The production of the final medical service becomes less efficient and the excess demand is larger than the case in the short run. Physicians have to work even longer hours in order to fulfill the excess demand,  $X_2 - X_1$ . In the right panel of Figure 4, the demand curve therefore shifts further to the left due to the prolonging working hours and the worsen quality of the final medical services. The result is summarized in the following proposition.

**Proposition 3.** *Suppose that after the implementation of the price-cut measure in the final medical service sector, the regulated price and physicians' long-run equilibrium working hours are such that  $\bar{p} l_p^{LR} < p^E \bar{l}_p$ . Then, the allocation of physicians becomes even more inefficient, with fewer physicians working for the high-risk specialty, i.e.*

$a^{*LR} > a^{*E}$ . Furthermore, compared to the case of the short-run equilibrium, physicians have to work more, while the consumption of the final medical service falls.

In the long run, when physicians further increase working hours as the case in Proposition 3, the quality of the final medical services continues deteriorating. The quality-adjusted price of the final medical services increases as a result. If the long-run equilibrium quality-adjusted price eventually rises above the original equilibrium price, agents in the goods sector are worse off. Therefore, the price-suppressing policy in the final medical service market indeed can create misallocation in the physicians market and result in a scenario where everyone in the economy is worse off.

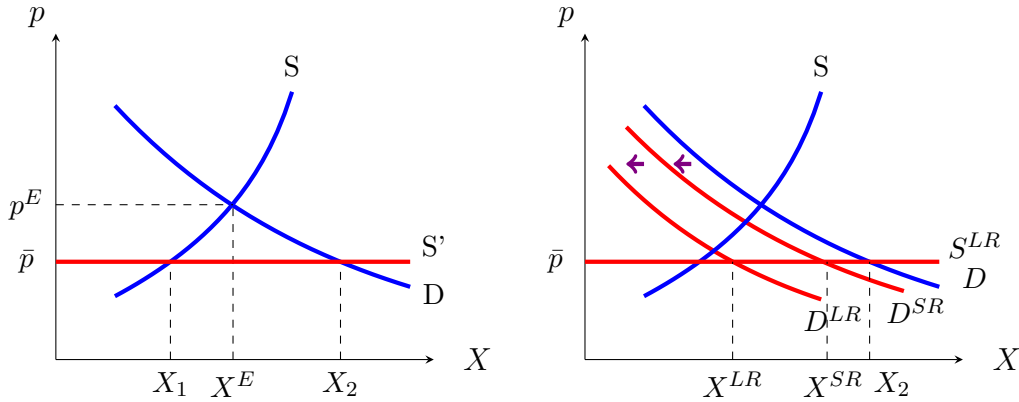


Figure 4: Immediate effects (left) and the long-run equilibrium effects (right) when physicians can adjust their specialty in response to the policy change.

## 6 Conclusion

As the general public gradually accepts the common values that regardless of one's wealth status, everyone shall have equal access to health care of quality and be protected against financial risks associated with health shocks, more and more countries have adopted universal health care system. Yet nothing comes for free. To cope with the aging population and the rising demand for health care, governments or UHI bureaus usually have to set targeted total health expenditures with measures to restrain medical costs. However, when governments or the UHI bureaus ensure the sustainability of the UHI by adopting cost control measures on the provider side, they often overlook the impacts such measures on the supply of medical service. This paper thus studies the possible supply-side distortions caused by the universal health care system, with a focus on the physician market.

More specifically, we develop a two-sector general equilibrium model of endogenous physician specialty choice to study the distortions in physician supply under the cost-suppressing UHI system. We show that in the short run, the general public are likely to be benefited from the universal health care when the quality of medical services deterioration is small. On the contrary, physicians are possible to be worse off because of prolonged working hours and lower income. In the long run when physicians of new cohorts respond to the supply-side cost control policies, it is possible that both the general public and physicians all get worse off under the UHI. Our paper thus has important policy implications: When a country is managing to take care of the current poor and the unfortunate, it shall also consider the long-run impacts of the policy enacted. The bottom line is that future generations should not be sacrificed for the good of the current generations.

This paper is meant to provide a parsimonious model to indicate the supply-side distortions and possible consequences resulting from any supply-side cost-suppressing UHI. Therefore, we restrain from complicating the model by introducing the financing-side of the universal health care, the age structure of the population, or the dynamic negotiation between governments or insurance bureaus and health service providers. A ready extension of the paper is to introduce the financing-side of the universal health care and the age structure of both physicians and workers into the model, and bring the model to the data of the country that we are interested in. In this way, we will be able to study issues such as the sustainability of the universal health care system and the shortage of physicians. We will leave this extension on our research agenda.

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# A Appendix

## A.1 Proof

**Lemma 1.** *There exists a unique solution for  $a^*$  if  $\frac{pB_H\bar{a}^\gamma\bar{l}_p}{b^{-1/\kappa}\lambda_H} > 1$ . Furthermore,  $a^*$  is decreasing in  $p$ , and approaches a constant  $C$  when (i)  $p$  goes to infinity, (ii)  $q = 0$ , or (iii)  $\lambda_H = 0$ .*

*Proof.* Rearranging equation (12) and substitute it into equation (15), we have

$$\begin{aligned}
 a^{*\gamma} \left( 1 - \frac{1}{p} \left[ b^{1/(1-\kappa)} + \left( \frac{1-b}{b} \right)^{-\kappa/(1-\kappa)} \left[ \frac{B_H \int_{a^*}^{\bar{a}} a^\gamma dF(a)}{B_L F(a^*)} \right]^{-\kappa} (1-b)^{1/(1-\kappa)} \right] \frac{\lambda_H}{B_H a^{*\gamma} \bar{l}_p} \right)^q \\
 = \left( \frac{1-b}{b} \right) \left[ \frac{B_H \int_{a^*}^{\bar{a}} a^\gamma dF(a)}{B_L F(a^*)} \right]^{1-\kappa} \frac{B_L}{B_H} e^{\frac{\xi_H}{\beta}}
 \end{aligned} \tag{22}$$

As illustrated in Figure 5 below, from the above equation, we can see that the LHS is increasing in  $a^*$  with  $a^* \searrow 0$ , the LHS goes to  $-\infty$ . As  $a^* \nearrow \bar{a}$ , the LHS goes to  $\bar{a}^\gamma \left( 1 - \frac{b^{-1/\kappa}\lambda_H}{pB_H\bar{a}^\gamma\bar{l}_p} \right)^q$ . As for the RHS, we can see that the RHS is decreasing in  $a^*$ . When  $a^* \searrow 0$ , the RHS goes to infinity. While  $a^* \nearrow \bar{a}$ , the RHS goes to 0. Hence, there exists a unique  $a^*$  that solves equation (15) if  $\frac{pB_H\bar{a}^\gamma\bar{l}_p}{b^{-1/\kappa}\lambda_H} > 1$ . Moreover, as  $p$  increases, the LHS increases while the RHS remains unchanged. Hence, the  $a^*$  that solves equation (15) decreases. Finally, as  $p$  increases without bound, the LHS will converge to  $a^{*\gamma}$  while the RHS remains unchanged. As a result,  $a^*$  will converge to a constant  $C$  where  $C$  is the solution that solves

$$a^{*\gamma} = \left( \frac{1-b}{b} \right) \left[ \frac{B_H \int_{a^*}^{\bar{a}} a^\gamma dF(a)}{B_L F(a^*)} \right]^{1-\kappa} \frac{B_L}{B_H} e^{\frac{\xi_H}{\beta}} \tag{23}$$

We can see that the same result holds when  $\lambda_H = 0$  or  $q = 0$ .

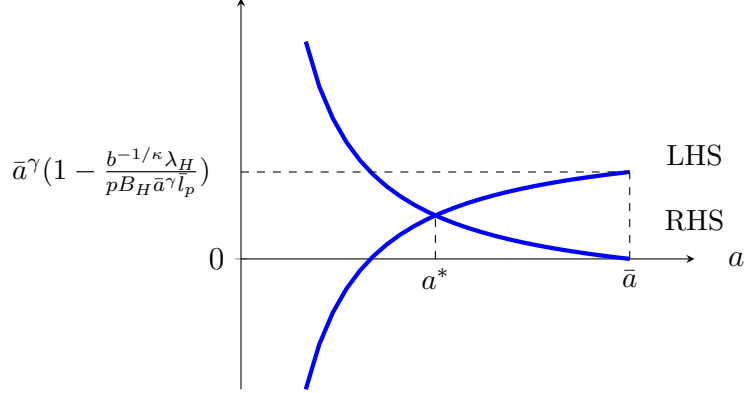


Figure 5: The determination of the threshold talent  $a^*$ .

□

**Lemma 2.** *Let the optimal allocation of physicians be the talent allocation that maximizes total output of the final medical services. Denote the cutoff in talent under the optimal allocation as  $a^o$ . Then, the threshold talent  $a^*$  under any competitive equilibrium, if exists, always satisfies the inequality  $a^o \leq C \leq a^*$ , with the first equality holds if and only if the cost of training  $\xi_H$  is zero and second equality holds if and only if one of the three conditions in Lemma 1 holds.*

*Proof.* The optimal allocation,  $a^o$ , is given by the solution to the following maximization problem.

$$\max_{a^*} \bar{l}_p \alpha \left\{ b \left[ B_H \int_{a^*}^{\bar{a}} a^\gamma dF(a) \right]^\kappa + (1-b) [B_L F(a^*)]^\kappa \right\}^{1/\kappa}$$

Solving this maximization problem gives us

$$a^{o\gamma} = \frac{1-b}{b} \left[ \frac{B_L \int_{a^o}^{\bar{a}} a^\gamma dF(a)}{B_H F(a^o)} \right]^{1-\kappa} \frac{B_L}{B_H} \quad (24)$$

From Lemma 1, we know that  $a^*$  is decreasing in  $p$  and converging to a constant  $C$ . Hence, we only need to show that  $a^o < C$ , which is obvious with  $\xi_H > 0$  when comparing equation (24) to equation (23). When  $\xi_H = 0$ , equations (23) and (24) coincide and  $a^o = C$ . The second equality is simply a consequence of Lemma 1. □

**Proposition 1.** *Let  $\tau$  be the discount quality of medical service in the short run. Assume that all physicians are forced to increase their working hours uniformly in order to fulfill the excess demand for the final medical services. In the short run, agents in the goods sector are better off if and only if  $p > p_\tau$ , where  $p_\tau \equiv \bar{p}/(1-\tau)$ .*

*Proof.* Since agents in the goods sector value only consumption, they will be better off if and only if they could consume more. More formally, agents in the goods sector will be better off if and only if

$$\begin{aligned}
A\tilde{l}(1 - e^{-h^E}) - p^E x^E &< A\tilde{l}(1 - e^{h^{SR}}) - \bar{p}x^{SR} \\
A\tilde{l}e^{-x^E} + p^E x^E &> A\tilde{l}e^{-(1-\tau)x^{SR}} + \bar{p}x^{SR} \\
p(1 + \log \frac{A\tilde{l}}{p}) &> \frac{\bar{p}}{1 - \tau}(1 + \log \frac{A\tilde{l}(1 - \tau)}{\bar{p}}) \\
p(1 + \log \frac{A\tilde{l}}{p}) &> p_\tau(1 + \log \frac{A\tilde{l}}{p_\tau})
\end{aligned}$$

where we use the demand equations to substitute out  $x^E$  and  $x^{SR}$  in the third inequality, and we define  $p_\tau \equiv \bar{p}/(1 - \tau)$  as the quality-adjusted price in the fourth inequality. Let  $g(p) = p(1 + \log \frac{A\tilde{l}}{p})$ . Differentiating  $g$  gives

$$\begin{aligned}
\frac{dg}{dp} &= \log \frac{A\tilde{l}}{p} \\
&> 0 \\
&\iff A\tilde{l} > p
\end{aligned}$$

Since  $p = A\tilde{l}(1 - \tau)e^{-(1-\tau)x} < A\tilde{l}$ , this implies that  $g'(p) > 0$ . Hence, agents in the goods sector are better off if and only if  $p > p_\tau$ .  $\square$

**Proposition 2.** *Suppose that the equilibrium price of the final medical service is  $1 + \log p^E < \log(A\tilde{l})$ . Then, all physicians are worse off in the short run with falling income and rising working hours.*

*Proof.* For the medical service sector, it is clear that physicians suffer from longer working hours. However, physicians' welfare might still increase if their income increases. Since the physicians' specialty allocation cannot be changed in the short run,  $a^*$  is a constant. We can see that the wages are proportional to the price of the final medical service and the working hours are proportional to the total quantity of medical services. As a result, the incomes of physicians are simply proportional to the total value of the medical sector. Before the intervention, the value of the total output in the medical sector is given by

$$p^E x^E = p^E \log \frac{A\tilde{l}}{p^E}$$

Differentiating the above expression gives  $\log \frac{A\tilde{l}}{p^E}$  which is greater than 0 if  $p < \frac{A\tilde{l}}{e}$ . Hence, if  $p^E$  is less than  $\frac{A\tilde{l}}{e}$ , physicians' income decreases and the whole medical service sector is worse off.  $\square$



## A.2 Government Intervention with Positive Price Wedge

Consider a model similar to the one in Section 5 with the government now intervening the market by subsidizing medical services with a lump sum tax. Let  $s$  be the price gap, or the price subsidy, between the consumer price and the provider price. We have

$$p_s = p_d + s$$

where  $p_s$  and  $p_d$  are the prices received by hospitals and paid by consumers, respectively. The demand and supply of health care in the short run are similar to equations (7) and (17) and are given as below:

$$p_d = A\tilde{l}(1 - \tau_p)e^{-(1-\tau_p)X/(1-\alpha)}$$

$$X^{SR} = l_p^{SR}\alpha \left\{ b \left[ B_H \int_{a^*E}^{\bar{a}} a^\gamma dF(a) \right]^\kappa + (1-b) [B_L F(a^{*E})]^\kappa \right\}^{1/\kappa}$$

Consider the case where the government implements UHI without affecting the equilibrium price that hospitals receive. The short-run (and long-run) effect can be summarized in the following figure.

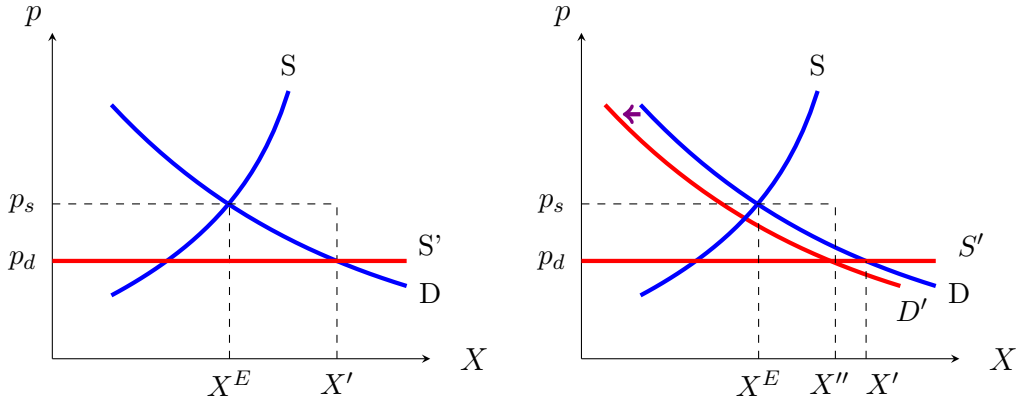


Figure 6: Immediate effects (left) and the short-run and long-run effects (right) when the government implements UHI.

Note that hospitals are still receiving the price  $p_s = p^E$  and the prices of the high- and the low-risk healthcare services are unaffected. The excess demand of medical services will be fulfilled by higher working hours of physicians. Under the assumption of uniform increases in working hours across the high- and the low-risk specialties, physicians will not adjust their specialty choice. As a result, there are no long-run adjustments in talent allocation. Since physicians are overworked, the quality of medical services decreases

and the demand for health care drops. To summarize, without price suppressing on the provider side, UHI itself will not distort the allocation of physicians. The changes in the welfare will depend on how the tax is levied across sectors. Nonetheless, the workers in the goods sector now can enjoy more and cheaper healthcare services.

Now consider the case where the government decides to adopt a global budget with a spending limit  $B$ . That is, the total subsidy (the price gap multiplied by the final quantity of medical services) to health expenditures shall not exceed  $B$ . Suppose that the targeting spending  $B$  is smaller than what the government is subsidizing under the current price subsidy  $s$ . As the government wants to hold the consumers' out-of-pocket price  $p_d$  constant, the government needs to negotiate a new price subsidy  $s' < s$  with the medical sector.

Let  $p'_s$  be the new price that hospitals receive from providing healthcare services. It is straightforward that  $p'_s < p_s$ . We can see that the impact of the global budget on the medical service sector is very similar to that of a price ceiling on providers, and the analysis in Section 5 all goes through. Figure 7 shows what happen in the short run. When physicians cannot adjust their specialty, the effect is exactly the same as the case shown in Figure 6 except that physicians are earning less. In the long run, as the prices of the high- and the low-risk healthcare services are suppressed under the global budget, physicians will adjust their specialty choice with more physicians choosing the low-risk specialty. As a result, the medical service production becomes less efficient. The right panel of Figure 8 plots the long-run effects where the excess demand leads to longer working hours of physicians, and brings down the quality of medical services.

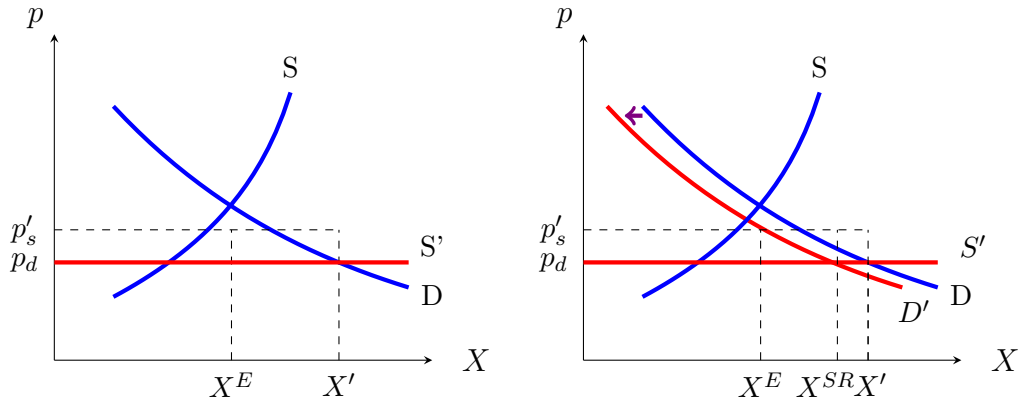


Figure 7: Immediate effects (left) and the short-run effects (right) when the government implements UHI with a global budget.

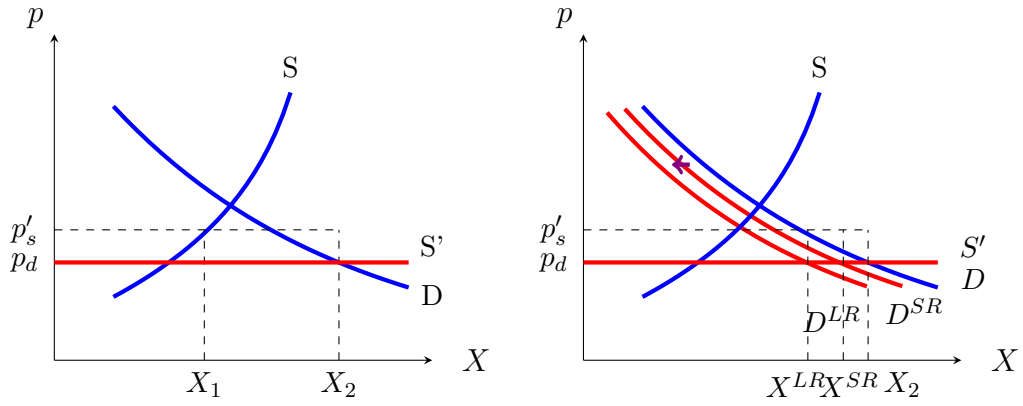


Figure 8: Immediate effects (left) and the long-run equilibrium effects (right) when the government implements UHI with a global budget.