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Kurt R. Brekke
Luigi Siciliani
Odd Rune Straume

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Universidade do Minho
Escola de Economia e Gestão

Competition, quality and integrated health care*

Kurt R. Brekke† Luigi Siciliani‡ Odd Rune Straume§

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Abstract

Integration of health care services has been promoted in several countries to improve the quality and coordination of care. We investigate the effects of such integration in a model where providers compete on quality to attract patients under regulated prices. We identify circumstances under which integration either increases or reduces the quality of services provided. In the absence of synergies related to costs or benefits, integration generally leads to increases in quality for some services and reductions for others. The corresponding effect on health benefits depends largely on whether integration leads to quality dispersion or convergence across services.

Keywords: Integrated care, quality, competition, health care.

JEL Classification: I11, L12, L13.

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†Department of Economics, Norwegian School of Economics (NHH), Helleveien 30, N-5045 Bergen, Norway. E-mail: kurt.brekke@nhh.no.

‡Department of Economics and Related Studies, University of York, Heslington, York YO10 5DD, UK; E-mail: luigi.siciliani@york.ac.uk

§Corresponding author. Department of Economics/NIPE, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal; and Department of Economics, University of Bergen. E-mail: o.r.straume@eeg.uminho.pt

1 Introduction

Quality of care is a key concern in the health sector. Improving quality and patient health remains a primary motivation behind several health system reforms. For decades several OECD countries have promoted competition and patient choice among publicly funded hospitals in order to improve quality of care (EXPH, 2015; OECD, 2012). If patients have limited or no co-payments, providers have to compete on quality to attract patients and increase revenues. However, there is growing concern that current models of care are not adequate for health systems facing an ageing population and rising chronic conditions because they lead to fragmented care.

The advocated solution to address fragmentation of services is for providers to offer integrated care in exchange for a single bundled payment covering all the services provided. In turn, this requires coordination across different sectors within and beyond the healthcare sector with the ambition of delivering a better patient experience (Stokes et al., 2018). However, the idea of integration runs, at least to some extent, against the working mode of competition as patient choice is restricted. Under integration the patient has to obtain all services from the same provider, and cannot obtain one service from the preferred provider and another service by a different provider.

One example of countries moving from competition to integration is England, where a series of market oriented reforms were introduced in the past. In 2003 a prospective payment system which reimburses hospitals a fixed tariff for each patient treated, known as Healthcare Resource Groups (similar to Diagnosis Related Groups in the US), was progressively rolled out. From 2006 patients had to be offered a choice of at least four hospitals by their primary care physician and from 2008 they could choose any qualified provider, whether NHS or private. In more recent years, the competition focus started to fade. A range of integrated care models, such as the Vanguard New Care Models in 2015, have been developed with the broad aim of integrating health and social care services. A first model is the multispecialty community provider model, where groups of GP practices come together to offer a range of services, including community and outpatient services, with the hospital sector acting as a separate entity. A second model involves integrating primary, community, mental health and hospital services with the aim of improving coordination and shifting care away from the secondary sector. Other configurations are possible, with integration of services covering the whole populations, or segments of the population with specific needs with a focus on single disease management models (Collins, 2016). The evidence on the effect of these forms of integration remains limited, and the changes required to implement integrated care may be complex and take longer to deliver than expected (Baxter et al., 2018; Kumpunen et al., 2020) and even its definition may vary across areas (Lewis and Ling, 2020).

The recent White Paper "Integration and innovation: working together to improve health and social care for all" (2021), which sets out legislative proposals for England, further emphasises the need of moving towards integrated care to join up care between primary care, community care, secondary care and mental health services, and to avoid organisational silos and remove barriers to cumbersome boundaries to collaboration. It also mentions that whilst competition can drive service improvement, it can also hinder integration between providers. It further mentions plans to remove powers from the Competition and Markets Authority to review hospital mergers. These proposals make apparent possible tensions between competition and integration reforms.

Similar initiatives on integrated care have been introduced in other countries. In the Netherlands, since 2008, health insurers have contracted with networks of GPs to support primary care coordination through care groups and used bundled payments for chronic conditions such as diabetes, chronic obstructive pulmonary disease and those at higher risk of cardiovascular disease, and for care for people with multi-morbidities (van Dijk et al., 2014). Care groups are legal entities acting as contractors, employing providers to offer coordinated outpatient care, and organising the care necessary for managing these diseases. In Germany, disease management programmes for ten chronic conditions and integrated care contracts were introduced since 2002 to reduce lack of coordination across levels of care for individuals with chronic conditions or specific acute conditions (Busse and Stahl, 2014). Their principal aim is to coordinate services at the ambulatory care level.[1]

Despite the policy trend towards more integrated care, the economic research on the effects of integrated care on treatment quality and health benefits to patients remains limited. Our paper aims at reducing this lack of knowledge and thus inform the policy developments on integrated care. We provide a model which investigates the circumstances under which integration of health services within the health sector, or between the health and other sectors, increases or reduces the quality of services provided. We do so in a model where providers compete on quality to attract patients under regulated prices. We employ a Hotelling set-up to model a market with two different services and two different providers, with the two providers of each service located at the endpoints of a unit line. The providers set service quality independently and receive a fixed price per patient.

[1] General practioners play a key role as care coordinators making sure that evidence-based guidelines are used throughout the patient's pathway and treatment, and coordinate specialist involvement. Participating physicians receive financial compensation from sickness funds.

We allow providers to differ in demand responsiveness to quality and provider costs of services.

The model then compares equilibrium quality under two configurations: when services are not integrated, and when services are integrated. Integration is modelled as each provider offering both sets of services, and still competing on quality to attract patients for both services. This could be thought as arising as a result of a merger between two providers offering different services. The services are now offered as an integrated package but patient choice is restricted because the patient has to choose the same provider for all services.

We identify three different effects of integration on incentives for quality provision following integration of services. First, under integrated care, demand responds less to a marginal increase in quality of a particular service because the quality of a single service is relatively less important in attracting patients across services. This effect pulls towards weaker incentives for quality following integration. Second, under integrated care patients demand more services from the same provider, so that each additional patient is more valuable to the provider and is reimbursed under a bundled payment covering all the services provided. This effect pulls towards stronger incentives for quality following integration. Third, because demand can differ under integrated care, the marginal cost of providing quality will also differ but whether this effect strengthens or weakens incentives for quality is *a priori* indeterminate.

To further characterise the effects of integration, we first assume that providers are identical, but services differ in demand responsiveness to quality, provider costs, regulated prices, and patient valuations of quality. We subsequently make the reverse assumption, that services are identical but there are cost differences between the providers. In the absence of any synergies on benefits or costs, two consistent patterns emerge from the analysis of the effects of integrated care under different types of asymmetry across services. First, integration leads to a quality increase for one type of service and a quality reduction for the other type of service. Second, patients experience an increase in health benefits across services if integration leads to an increase in quality dispersion across services. By an increase in quality dispersion we mean that the service with higher quality further improves, while the other service experiences a reduction in quality, as a result of integration. The results are reversed if the services are characterised by quality convergence, in which case health benefits reduce as the reduction in quality from the service with initially higher quality dominates over the health benefit arising from the quality increase of the service with initially lower quality.

We then explore the further insights arising from cost asymmetries across providers. We show that when integrated care leads to quality convergence, the health benefit of all patients (those who switch provider as well as those who stay with the same provider after integration) is reduced. The health effect is instead indeterminate in the presence of quality dispersion for both switchers and stayers. Stayers are affected by integration only through changes in quality, while switchers are affected by both changes in quality and transportation costs. The effects of integration on welfare, defined as the differences between patient utilities and provider costs, are generally ambiguous, but we are able to characterise them as a function of key demand and supply parameters. We finally show that the presence of synergies on costs or benefits generally lead to quality improvements.

Overall, our analysis cautions against possible reductions in quality that may arise as a result of integration. The study is organised as follows. Section 2 briefly reviews the literature. Section 3 presents the key assumptions of the model. Section 4 derives the equilibrium quality when services are not integrated, whereas the equilibrium quality provision under service integration is derived in Section 5. Section 6 compares equilibrium quality under the two scenarios. Section 7 is devoted to welfare analysis, whereas Section 8 briefly describes the effect of synergies on equilibrium quality provision. Finally, some concluding remarks are offered in Section 9.

2 Related literature

Our paper relates to the literature on competitive effects of provider integration in health care markets.[2] This literature can be divided into two separate categories, i.e., studies of the effects of *horizontal* integration and studies of the effects of *non-horizontal* integration. The literature on horizontal integration, especially on hospital mergers, is large; see, for instance, the reviews by Gaynor and Town (2012) and Gaynor et al. (2015). A key lesson from this literature is that the competitive effects of integration is likely to depend on the institutional setting. For instance, less competition between hospitals tend to result in lower quality of care when prices are regulated, though the opposite can also arise.[3] However, if prices are market based, hospital mergers tend to result in higher prices while the effects on quality are more ambiguous.[4]

[2] Our paper relates also to the broader literature on competition in health care markets, including the effects of stronger competition or entry. See Gaynor and Town (2012) for an extensive review, and also Brekke et al. (2018) for a review of the theoretical literature.

[3] See, e.g., the empirical studies by Cooper et al. (2011), Gaynor et al. (2013), Brekke et al. (2021), and Moscelli et al. (2021). In a theoretical study on hospital mergers under regulated prices, Brekke et al. (2017a) show that a merger leads to lower quality for all hospitals if they are sufficiently profit-oriented.

[4] See the literature review by Gaynor et al. (2015). These findings can be explained by the theoretical studies of Gaynor et al. (2006) and Brekke et al. (2017b).

While we study competitive effects of provider integration, our paper differs from the above-mentioned literature in that we restrict attention to non-horizontal integration of providers of care. In particular, we study integration of providers that offer complementary health services, which relates to the literature of vertical or conglomerate mergers in health care. The literature on non-horizontal integration is much more sparse; see the review by Gaynor et al. (2015).[5] However, there has been a growing number of studies on vertical integration of hospitals and physician practices, mainly from the US. For instance, Baker et al. (2016) find that hospital ownership of physician practices affects their patients' hospital choices. Specifically, they find that a hospital's ownership of a physician practice dramatically increases the probability that the physician's patients will choose the owning hospital. They also find that patients are more likely to choose a high-cost, low-quality hospital when their physician is owned by that hospital. Another study by Baker et al. (2014) find that increases in the market share of hospitals that own physician practices are associated with higher hospital prices and spending, whereas increases in the market share of hospitals that are contractually integrated with physicians are associated with a small reduction in the volume of admissions. Similar findings are reported by Capps et al. (2018).

There is also a growing literature on Accountable Care Organizations (ACOs), which is a new model for integrated health care delivery created by the Obama administration's Patient Protection and Affordable Care Act. ACOs are designed to promote integrated care by allowing a network of hospitals and providers to jointly contract with the Center for Medicare and Medicaid Services to provide care to a population of Medicare patients. The key feature of these contracts is the use of shared savings to contain costs combined with incentives to maintain care quality at acceptable levels. Frandsen and Rebitzer (2015) calibrate a model of optimal ACO incentives using proprietary performance measures from a large insurer. They find that free-riding is a problem and causes optimal incentive payments to exceed cost savings unless ACOs simultaneously achieve large efficiency gains. Baker et al. (2015) simulated how a decision of a hypothetical hospital to form an Accountable Care Organization through the purchase of physicians in a hypothetical county translates into changes in prices and spending. They find that such mergers can lead to statistically significant and economically meaningful increases in prices and spending, and affect patients differently depending on their local hospital market conditions. Frandsen et al. (2019)

[5] There is an extensive literature on evaluation studies, especially cost-effect studies, of specific small-scale integrated care interventions (see for instance Rocks et al., 2020). We focus on wider policy initiatives like the recent integrated care initiative in the UK for which the literature is much more sparse.

provide a common-agency framework to model fragmentation of care amongst payers and explain historical reliance on single-specialty (non-integrated) practices to deliver care.

There are also related studies of similar integration programs. Norton et al. (2018) study the Medicare Hospital Value-based Purchasing Program (HVBP), which rewards or penalises hospitals based on their quality and episode-based costs of care and incentivises integration between hospitals and post-acute care providers. They find evidence that hospitals improved their performance over time in the areas where they have the highest marginal incentives to improve care, and that integrated hospitals responded more than non-integrated hospitals. A related study is Konetzka et al. (2018) who examine how integration between hospitals and post-acute care providers (skilled nursing facilities and home health agencies) affects payment and rehospitalisation in the US Medicare scheme. They find that vertical integration between hospitals and skilled nursing facilities increases payments but reduces rehospitalsation rates, while vertical integration between hospitals and home health agencies has little effect.

Our paper differs from the above studies in that we consider how (non-horizontal) provider integration affects quality incentives rather than cost savings. There is growing empirical evidence related to integration of services also in other countries. Fernandez et al. (2017) examine whether coordination between hospitals and local authorities in England affect post-operative hospital length of stay for elderly hip replacement patients, and provide evidence that the lack of coordination across local authorities can increase post-operative length of stay. Morciano et al. (2020) show that hospital emergency admissions grew at a slower pace under the Vanguard programmes integrating health and social care relative to other areas in England, but no effect was identified on bed days. In the Netherlands, de Bakker et al. (2012) found improvements in the organisation and coordination of care for diabetes, and better protocol adherence, but increased administrative costs and large price variations unrelated to quality.

Our paper contributes to the existing literature by providing a framework for investigating the competitive effects of integrated care on quality incentives in a setting with regulated prices, which is mainly relevant for European based health schemes and the US Medicare.

3 Model

Consider a market with two different services, denoted A and B, offered either within the health sector (primary care, secondary care, or rehabilitation services) or between the health and other sectors (community care or social care). Service A is offered by two different providers, denoted $A1$ and $A2$, whereas Service B is offered by two other providers, denoted $B1$ and $B2$.[6] Two providers of each service are located at the endpoints of a unit line. Providers $A1$ and $B1$ are located on the left endpoint, and Providers $A2$ and $B2$ are located at the right endpoint. A unit mass of patients are uniformly distributed along the same line, and each patient demands one unit of each type of service.

Suppose that all patients are fully insured, so that each service is free at the point of consumption. Consider a patient located at $x \in [0, 1]$ who receives one unit of Service A from Provider Ai and one unit of service B from Provider Bj. The utility of this patient is assumed to be given by

$$V(x, Ai, Bj) = v + b_A q_i^A + b_B q_j^B - t_A |x - z_{Ai}| - t_B |x - z_{Bj}|, \qquad (1)$$

where z_{Ai} and z_{Bj} are the locations of providers Ai and Bj, respectively, and q_i^A and q_j^B are the qualities of service offered by the same two providers. The parameters $b_k > 0$ and $t_k > 0$ measure the marginal benefit of quality and the marginal transportation (or mismatch) cost, respectively, for Service k. Since we allow t_A to be potentially different from t_B, these transportation costs are better interpreted as mismatch costs in product differentiation space. Regardless of interpretation, though, t_k reflects (inversely) the demand elasticity with respect to quality in the market for Service k. Finally, we assume that the utility parameter $v > 0$ is sufficiently large to ensure that both markets are always fully covered.

The cost of provision of Service k for Provider ki is assumed to be given by

$$C_i^k\left(q_i^k, D_i^k\right) = c_i^k q_i^k D_i^k + \frac{w}{2}\left(q_i^k\right)^2; \quad k = A, B, \quad i = 1, 2, \qquad (2)$$

where D_i^k is the demand facing Provider ki, and where $c_i^k > 0$ is a provider- and service-specific cost parameter. Thus, we assume that the marginal cost of quality for a given service increases in output, implying that parts of the costs of quality provision are patient specific. We also allow these costs to vary across services ($c_i^A \neq c_j^B$) and across providers of the same service ($c_1^k \neq c_2^k$).

We assume that service provision is financed by a third-party payer according to a service

[6] For example, within the health sector service A could relate to primary care services offered by GP practices, or relate to post-operative rehabilitation services offered by specialised clinics, and service B could relate to outpatient or inpatient hospital care. Across sectors, service A could relate to primary care and service B to social care, community care, or mental health services.

specific contract (T_k, p_k), where $T_k > 0$ is a lump-sum transfer and $p_k > 0$ is a price per unit of service, given to each provider of Service k.[7] We also assume that the providers are semi-altruistic, implying that Provider ki attaches a weight $\alpha > 0$ to the health benefit $(b_k q_i^k)$ of each patient served by the provider. The payoff of Provider ki is then given by

$$\pi_i^k = T_k + \left(p_k + \alpha b_k q_i^k - c_i^k q_i^k\right) D_i^k - \frac{w}{2}\left(q_i^k\right)^2. \tag{3}$$

We make a restriction on the providers' degree of altruism such that $\alpha \in \left[0, c_i^k/b_k\right)$, which implies that qualities are strategic complements for competing providers and also ensures that the optimal quality provision of each provider is increasing in the per-unit price p_k.

4 Non-integrated services

As a benchmark for comparison, consider the case in which each patient can freely choose the provider for each of the two services. With utility maximising choices, the demand for Provider ki is given by

$$D_i^k = \frac{1}{2} + \frac{b_k\left(q_i^k - q_j^k\right)}{2t_k};\ k = A, B,\ i, j = 1, 2,\ i \neq j. \tag{4}$$

Inserting (4) into (3) and maximising with respect to q_i^k, the optimal quality offered by Provider ki, given the quality offered by the competing provider, is implicitly given by

$$\frac{\partial \pi_i^k}{\partial q_i^k} = \left[p_k - \left(c_i^k - \alpha b_k\right) q_i^k\right] \frac{\partial D_i^k}{\partial q_i^k} - \left[\left(c_i^k - \alpha b_k\right) D_i^k + w q_i^k\right] = 0, \tag{5}$$

where $\partial D_i^k / q_i^k = b_k/2t_k > 0$. The first term in (5) is the marginal payoff of quality provision, which is given by the marginal net benefit of attracting more patients by increasing the quality of the service, times the demand responsiveness to quality. The marginal net benefit is partly financial, consisting of the price-cost margin $(p_k - c_i^k q_i^k)$, and partly altruistic, consisting of the value attached to health benefits $(\alpha b_k q_i^k)$. These net benefits must be weighed against the marginal cost of quality provision, which is given by the second term in (5). It is easy to see that an interior solution to this problem (i.e., $q_i^k > 0$) requires that p_k is sufficiently large, such that the net benefit of attracting

[7] Hospitals are typically paid by a DRG (Diagnosis Related Groups) payment system with a fixed price for every patient treated. Primary care is typically paid by capitation or fee for service, therefore the price could be interpreted either as a capitation payment for each patient registered with the practice, or a fee for each patient visit. Under integrated care, the provider typically receives a bundled payment, again a form of fixed price, for all the services covered.

more patients is positive.

By solving (5) with respect to q_i^k, we derive the best-response function of Provider ki, which is given by

$$q_i^k\left(q_j^k\right)=\frac{p_k b_k+\left(b_k q_j^k-t\right)\left(c_i^k-\alpha b_k\right)}{2\left(wt_k+b\left(c_i^k-\alpha b_k\right)\right)};\; k=A,B,\, i,j=1,2,\, i\neq j. \quad (6)$$

We see that qualities are strategic complements, implying that a quality increase by one provider will induce a quality increase also from the competing provider. The reason for this type of strategic interaction is cost related. Higher quality by one provider leads, all else equal, to a demand loss for the competing provider. But lower demand implies that the marginal cost of quality provision goes down, so the optimal response for the competing provider is to choose a higher level of quality.

Assuming that all providers make simultaneous and non-cooperative choices, the quality chosen by Provider ki in the Nash equilibrium for non-integrated services is given by[8]

$$q_i^{kN}=\frac{p_k b_k\left(2wt_k+b_k\left(c_i^k+2c_j^k-3\alpha b_k\right)\right)-t_k\left(c_i^k-\alpha b_k\right)\left(2wt_k+3b_k\left(c_j^k-\alpha b_k\right)\right)}{4wt_k\left(wt_k+b_k\left(\left(c_i^k+c_j^k\right)-2\alpha b_k\right)\right)+3b_k^2\left(c_j^k-\alpha b_k\right)\left(c_i^k-\alpha b_k\right)}; \quad (7)$$

$k=A,B,\, i,j=1,2,\, i\neq j$.

5 Integrated care

Suppose now that the two services are integrated at each endpoint of the unit line, such that both services (A and B) are offered by Provider 1, located at the left endpoint, and by Provider 2, located at the right endpoint. We can think of this as a 'merger' between Provider $A1$ and $B1$, and between $A2$ and $B2$, respectively. The direct implication for the patients is that both services must now be obtained from the same provider. Thus, when the two services are offered as an integrated package, patient choice is restricted in the sense that each patient chooses only between two providers and obtains both services from the chosen provider. Formally, this implies that $i=j$ in the utility function given by (1).

If each patient makes a utility maximising choice, the demand facing Provider i is now given by

$$D_i=\frac{1}{2}+\frac{\sum_k b_k\left(q_i^k-q_j^k\right)}{2\sum_k t_k};\; k=A,B,\, i,j=1,2,\, i\neq j, \quad (8)$$

[8] Throughout the paper we use superscript N to indicate equilibrium values in the case of non-integrated care.

where each of the D_i patients demands two services from Provider i – one unit of A and one unit of B.

We assume that the prices and costs of each service remain the same after integration, or equivalently that the price paid for integrated care is the sum of the two prices before integration. The payoff of Provider i is given by

$$\pi_i = \sum_k \left[T_k + \left(p_k + \alpha b_k q_i^k - c_i^k q_i^k \right) D_i - \frac{w}{2} \left(q_i^k \right)^2 \right]; \; k = A, B, \, i, j = 1, 2, \, i \neq j, \tag{9}$$

where D_i is given by (8). The first-order condition for the optimal quality of Service k offered by Provider i is given by

$$\sum_{s=A,B} \left(p_s + \alpha b_s q_i^s - c_i^s q_i^s \right) \frac{\partial D_i}{\partial q_i^k} - \left[\left(c_i^k - \alpha b_k \right) D_i + w q_i^k \right] = 0, \tag{10}$$

where $\partial D_i / \partial q_i^k = b_k / 2 \left(t_A + t_B \right)$.

Solving (10) with respect to q_i^k, the best-response function of Provider i for the quality of Service k is given by

$$q_i^k \left(q_i^{-k}, q_j^k, q_j^{-k} \right) = \frac{\sum_{s=A,B} \left[p_s b_k - \left(c_i^k - \alpha b_k \right) t_s - b_s \left(c_i^s - \alpha b_s \right) q_i^{-k} + b_s \left(c_i^k - \alpha b_k \right) q_j^s \right]}{2 \left(w \sum_{s=A,B} t_s + b_k \left(c_i^k - \alpha b_k \right) \right)}, \tag{11}$$

where $i, j = 1, 2$, $i \neq j$, and where superscript $-k$ denotes the other service than k. Under integrated care, we see that the optimal quality of Service k for Provider i depends on the qualities of all other services: the quality of the provider's other service (q_i^{-k}) and the quality of both services offered by the competing provider (q_j^k and q_j^{-k}).

The quality of Service k is a *strategic complement* to the quality of either of the two services offered by the competing provider, and the reason is identical to the one causing strategic complementarity in the non-integrated case. An increase in the quality of any of the services offered by Provider j will shift demand away from Provider i, thereby causing a reduction in the marginal cost of quality provision for the latter provider.

On the other hand, the qualities of the two services offered by Provider i are *strategic substitutes* (i.e., $\partial q_i^k / \partial q_i^{-k} < 0$). All else equal, a higher quality of Service k increases the demand for Provider i, thereby increasing the demand also for Service $-k$ offered by the same provider. This increases the marginal cost of quality provision and therefore reduces the optimal quality chosen for this service, all else equal.

The closed-form expression for equilibrium quality of Service k by Provider i is rather involved and thus not reported here. Instead we will present the equilibrium expressions for several special cases in the following analysis.

6 Effects of integrated care on quality provision

How does integration of services affect the quality of each service offered? If we compare the first-order conditions for optimal quality provision with and without integration, i.e., (5) and (10), respectively, we can identify three different effects of integration on incentives for quality provision:

(I) Under integrated care, demand responds less to a marginal increase in the quality of a particular service; i.e., $\partial D_i/\partial q_i^k$ is smaller than $\partial D_i^k/\partial q_i^k$, simply because the quality of a single service is of relatively less importance when patients choose between 'packages' containing more than one service. All else equal, this effect pulls in the direction of *weaker* incentives for quality provision as a result of integration.

(II) On the other hand, since the patients demand two services from the same provider under integrated care, each extra patient is more valuable to the provider. In other words, the marginal net benefit of attracting more patients is larger under integrated care. All else equal, this effects pulls in the direction of *stronger* incentives for quality provision as a result of integration.

(III) Finally, since demand for Provider i under integrated care (D_i) is not necessarily equal to demand for Service k from Provider ki in the absence of integration (D_i^k), the marginal cost of quality provision might also be different. However, whether integration leads to weaker or stronger incentives for quality provision through this effect is *a priori* ambiguous.

Since effects I and II go in opposite directions and the sign of effect III is indeterminate, the overall effect of integrated care on quality provision is also *a priori* indeterminate. In the special case of complete symmetry (i.e., $b_A = b_B$, $t_A = t_B$, $p_A = p_B$ and $c_1^k = c_2^k$), integrated care means that the demand responsiveness to quality is halved in magnitude, whereas the net benefit of each patient is doubled, implying that effects I and II exactly cancel each other. Furthermore, equilibrium demand (in terms of number of patients) for Provider ik under non-integration is equal to equilibrium demand for Provider i under integration, implying that effect III is zero. Consequently, under full symmetry, integrated care has no implications for equilibrium quality provision.

However, in the case of asymmetries across services or across providers, equilibrium quality provision for each type of service is generally different under integrated care. In the following, we will consider each of the potential asymmetries separately, and analyse the implications of each of these asymmetries for the effect of integration on incentives for quality provision.

6.1 Asymmetries across services

Suppose that the cost of quality provision for Service k is the same for both providers of this service, i.e., $c_i^k = c_j^k = c^k$, $k = A, B$, but that there are asymmetries between the two services in terms of costs, prices, demand elasticities or quality benefits. In this case, the equilibrium quality of Service k in the absence of integration is given by

$$q^{kN} = \frac{p_k b_k - t_k \left(c^k - \alpha b_k\right)}{2wt_k + b_k \left(c^k - \alpha b_k\right)}, \tag{12}$$

whereas, under integrated care, equilibrium quality for the same service, denoted by q^{kI}, is given by[9]

$$q^{kI} = \frac{2w \sum_{s=A,B} \left[b_k p_s - \left(c^k - \alpha b_k\right) t_s\right] + \left(c^{-k} - \alpha b_{-k}\right) \left(b_k c^{-k} - b_{-k} c^k\right)}{2w \sum_{s=A,B} \left[2wt_s + b_s \left(c^s - \alpha b_s\right)\right]}. \tag{13}$$

Interior solutions (i.e., $q^{kN} > 0$ and $q^{kI} > 0$) require that the per-unit prices are sufficiently high, such that the net benefit of attracting patients is strictly positive for Provider i at zero quality.

Below we investigate the implications of each of the service-specific asymmetries separately, while preserving the assumption of symmetric providers. Notice that provider symmetry implies equal market shares for all providers in equilibrium, with or without integration, which means that effect III, as explained above, vanishes. Thus, all potential impacts of integrated care on equilibrium quality provision go through effects I and II.

Our analysis also includes an assessment of the effect of integrated care on patients' health benefit. Due to the assumption of symmetry across providers, the change in health benefit is equal for all patients and given by

$$\Delta H = \sum_{k=A,B} b_k \Delta q^k, \tag{14}$$

where $\Delta q^k := q^{kI} - q^{kN}$ is the change in the equilibrium quality of Service k as a result of integrated

[9] Throughout the paper we use superscript I to indicate equilibrium values in the case of integrated care.

care.

6.1.1 Cost differences

Suppose that $c^A \neq c^B$, while the other key parameters are equal across the two services (i.e., $p_A = p_B = p$, $t_A = t_B = t$ and $b_A = b_B = b$). In this case, the effect of integration on quality provision is characterised as follows:

Proposition 1 *Suppose that the two services differ only in terms of the cost of quality provision. Then there exists a threshold level of the per-unit price, given by*

$$\widehat{p} := \frac{2w\left(t\left(c^k + c^{-k}\right) - 2\alpha bt\right) + b\left(c^k - \alpha b\right)\left(c^{-k} - \alpha b\right)}{2bw}, \tag{15}$$

such that:

(i) If $p < \widehat{p}$, integrated care leads to a quality decrease (increase) for the service with higher (lower) marginal cost of quality provision, thus a quality dispersion, and an increase in patients' health benefit.

(ii) If $p > \widehat{p}$, integrated care leads to a quality increase (decrease) for the service with higher (lower) marginal cost of quality provision, thus a quality convergence, and a reduction in patients' health benefit.

If $t_A = t_B$ and the providers are symmetric, the result in the above proposition is explained only by effect II, as defined at the beginning of this section. Suppose that $c^A < c^B$. In this case, the marginal net benefit of attracting more patients is higher for a provider of Service A than for a provider of Service B when the services are not integrated, implying that the quality of Service A is higher in equilibrium. Under integrated care, however, the comparable net benefit of attracting patients by increasing the quality of Service k is the *average* of the marginal net benefits for Provider Ai and Provider Bi under non-integration. Thus, if the marginal net benefit of attracting patients is higher for Service A than for Service B in the non-integrated equilibrium, integrated care implies a *reduction* in the marginal net benefit of attracting demand through the quality of Service A, and a corresponding *increase* for Service B. This implies in turn that integration leads to a quality reduction for Service A and a quality increase for Service B. The opposite is true if the marginal benefit of attracting patients is lower for Service A than for Service B in the non-integrated equilibrium.

With our assumptions of equal per-unit prices for the two services, the marginal net benefit of attracting patients is higher for Service A than for Service B if the marginal cost of service provision is lower for Service A than for Service B. Since the marginal cost of providing Service k is given by $c^k q^k$, the relative size of marginal costs is determined by two counteracting effects; if $c^A < c^B$, then $q^A > q^B$ in the non-integrated equilibrium, making the comparison *a priori* indeterminate. In our model, though, it is easily verified that the effect of $c^A < c^B$ dominates the effect of $q^A > q^B$ if the per-unit price is sufficiently high, implying $c^A q^A < c^B q^B$, whereas the opposite is true for prices below the threshold level given in Proposition 1. The reason is that a higher price leads to higher quality provision for both services, which amplifies the effect of $c^A < c^B$ in a comparison between $c^A q^A$ and $c^B q^B$. Thus, by the reasoning given above, integrated care leads to quality dispersion if the price is sufficiently low and a quality convergence otherwise.

The effect of integrated care on patients' health benefit is generally ambiguous, since integration implies a quality reduction for one service and a quality increase for the other. It turns out that the quality reduction dominates if it applies to the service with higher quality before integration, which is the case if $p > \widehat{p}$, whereas the opposite holds if $p < \widehat{p}$. Thus, patients benefit from quality dispersion and suffer from quality convergence.

6.1.2 Price differences

Suppose that $p_A \neq p_B$, while the other key parameters are equal across the two services (i.e., $c^A = c^B = c$, $t_A = t_B = t$ and $b_A = b_B = b$). In this case, the effects of integrated care are the following:

Proposition 2 *Suppose that the two services differ only in terms of per-unit prices. Integrated care then leads to a quality decrease (increase) for the service with the higher (lower) price, thus a quality convergence. This has no effect on patients' health benefit.*

The intuition behind this result is somewhat similar to the intuition behind the second part of Proposition 1. Once more, only effect II is relevant. Suppose that $p_A > p_B$, which implies that the marginal net benefit of attracting patients is higher for Provider Ai than for Provider Bi under non-integration, leading to higher quality of Service A than Service B in equilibrium. Under integrated care, however, the absence of any cost differences implies that the marginal net benefit of attracting patients is the same for both types of quality provision (q^A and q^B), which in turn means that equilibrium quality is the same for both services. Since the comparable net benefit for each provider under integration is the average of the marginal net benefits for Provider Ai and Bi under non-integration, it follows that integration leads to a reduction in the quality of Service A and an increase in the quality of Service B. The opposite obviously holds if $p_A < p_B$.

Once more, integrated care implies that the quality of one service increases whereas the quality of the other service reduces. However, in terms of patients' health benefits, these two effects exactly cancel each other when they are only caused by price differences. In this case, patients are unaffected by integration.

6.1.3 Differences in demand elasticities

Suppose now that $t_A \neq t_B$. Under the assumption on no other asymmetries (i.e., $c^A = c^B = c$, $p_A = p_B = p$ and $b_A = b_B = b$), the effect of integrated care on quality provision is given as follows:

Proposition 3 *Suppose that the two services differ only in terms of demand elasticity with respect to quality. Integrated care then leads to an increase (decrease) in the quality of the service with less (more) elastic demand, thus a quality convergence. This causes a reduction in patients' health benefit.*

If the only asymmetry is related to differences in demand elasticities, the consequences of integrated care are purely explained by effect I. Suppose that $t_A > t_B$, which implies that patients' demand respond more strongly to quality changes for Service B than for Service A. Competition for patients therefore leads to higher equilibrium quality for Service B than for Service A under non-integration. Under integrated care, we know that the demand responsiveness to quality for Service k is lower. More specifically, the demand responsiveness is $b/2t_k$ under non-integration and $b/2\,(t_A + t_B)$ under integrated care. On the other hand, for a given quality level the net benefit of attracting one additional patient is exactly twice as high under integrated care. Since $b/2t_A$ is less than twice as large as $b/2\,(t_A + t_B)$, whereas $b/2t_B$ is more that twice as large as $b/2\,(t_A + t_B)$, it follows that integrated care causes an increase in the quality of Service A and a reduction in the quality of Service B. The opposite obviously applies if $t_A < t_B$.

Similarly to the case of price differences (Proposition 2), integrated care leads to complete quality convergence when the only asymmetry is related to differences in the demand elasticity of quality. In this case, however, patients always stand to lose from integration. In other words, the quality increase of one service is always more than outweighed by the quality reduction of the other. The reason is that the elasticity of demand with respect to the quality of Service k is convex in t_k. If $t_A > t_B$, this means that the difference $|b/t_k - 2b/(t_A + t_B)|$ is larger for $k = B$ than for $k = A$. As a result, integrated care leads to a drop in quality of Service B that is larger in magnitude than the increase in quality of Service A, thus causing a reduction in patients' health benefit.

6.1.4 Differences in quality benefits

Finally, suppose that $b_A \neq b_B$, whereas $c^A = c^B = c$, $p_A = p_B = p$ and $t_A = t_B = t$. The effect of integrated care on quality provision is then characterised as follows:

Proposition 4 *Suppose that the two services differ only in terms of the marginal benefit of quality. In this case there exists a threshold level of provider altruism, given by*

$$\widehat{\alpha} \in \left(\frac{c}{b_k + b_{-k}}, \min\left\{ \frac{c}{b_k}, \frac{c}{b_{-k}} \right\} \right), \tag{16}$$

such that:

(i) If $\alpha < \widehat{\alpha}$, integrated care leads to higher (lower) quality of the service with higher (lower) marginal benefit of quality, thus a quality dispersion, and an increase in patients' health benefit.

(ii) If $\alpha > \widehat{\alpha}$, integrated care leads to lower (higher) quality of the service with higher (lower) marginal benefit of quality, thus a quality convergence, and a reduction in patients' health benefit.

Notice first that $b_A \neq b_B$ also implies that demand elasticities are different across the two services, which in turn means that both effect I and II contribute to the impact of integrated care on quality provision. Suppose that $b_A > b_B$. In this case, the equilibrium quality is higher for Service A than for Service B under non-integration. There are two reasons for this. First, Provider Ai has more quality-elastic demand than Provider Bi. Second, if the providers are semi-altruistic (i.e., if $\alpha > 0$), the marginal net benefit of attracting patients is also higher for Provider Ai than for Provider Bi. However, these two mechanisms have opposite implications for the effects of integrated care on quality provision.

Consider first the case of $\alpha = 0$, which eliminates the second of the two aforementioned mechanisms. As long as $t_A = t_B$, the demand responsiveness to the quality of Service k is exactly halved as a result of integration. However, integrated care does not lead to a doubling of the marginal net benefit of attracting patients for any of the services. The reason is that, under integrated care, the marginal net benefit is given by $2\left(p - c\left(q^A + q^B\right)/2\right)$ under integration and $\left(p - cq^k\right)$ under non-integration. Since the quality of Service A is higher than the quality of Service B in equilibrium, the net marginal benefit of attracting patients under integrated care more than doubles for Service A and less than doubles for Service B. Consequently, integration leads to an increase (reduction) in the quality provision of Service A (Service B), implying a quality dispersion across the two services.

However, if $\alpha > 0$, an opposite effect is introduced. Because of semi-altruistic preferences, the net marginal benefit of attracting patients is higher for Provider Ai than for Provider Bi under non-integration. For given quality levels, the comparable marginal net benefit under integrated care is the average of the net marginal benefits under non-integration. All else equal, this implies that the net marginal benefit of attracting patients is reduced for Service A and increased for Service B as a result of integrated care. Thus, this mechanism pulls in the direction of quality convergence across the two services. The strength of this mechanism depends on the degree of provider altruism, and Proposition 4 confirms that this effect dominates if α is sufficiently high.

Similarly to all the previously cases analysed, integrated care leads to a quality increase for one service and a quality reduction for the other. In this case, though, the implications for patients' health benefits are fairly intuitive, since the overall effect is dominated by the quality change for the service with the higher marginal benefit of quality. This implies that integrated care increases (reduces) patients' health benefits if integration leads to quality dispersion (convergence).

A summary of the results derived in Propositions 1-4 is presented in Table 1. There are two quite consistent patterns that emerge from the analysis of the effects of care integration under different types of asymmetry across services: (i) Integration leads to a quality increase for one type of service and a quality reduction for the other service; and (ii) patients tend to benefit (lose) if integration leads to quality dispersion (convergence) across services.

[Table 1 here]

6.2 Asymmetries across providers

Let us now explore the role of cost asymmetries across the providers of the two services. In order to isolate the effect of asymmetric providers, suppose that there are no asymmetries across the two services; i.e., $b_A = b_B = b$, $t_A = t_B = t$, $p_A = p_B = p$ and $c_i^A = c_i^B$. However, the two providers have different marginal costs of quality provision; i.e., $c_i^k \neq c_j^k$. In order to ease the presentation, suppose that the cost asymmetries are such that Provider 1 (Provider 2) has a cost advantage in quality provision for Service A (Service B), and that these advantages are of equal size. More specifically, suppose that $c_1^A = c_2^B = c - \delta$ and $c_1^B = c_2^A = c$.

With these assumptions, the equilibrium qualities when services are *not integrated* are given by

$$q_1^{AN} = q_2^{BN} = \frac{(pb - t(c - \alpha b))(2wt + 3b(c - \alpha b)) + \delta\left(2wt^2 + b(3t(c - \alpha b) - bp)\right)}{(2wt + 3b(c - \alpha b))(2wt + b(c - \alpha b)) - \delta b(4wt + 3b(c - \alpha b))}, \tag{17}$$

$$q_1^{BN} = q_2^{AN} = \frac{(pb - t(c - \alpha b))(2wt + 3b(c - \alpha b)) + \delta b(3t(c - \alpha b) - 2bp)}{(2wt + 3b(c - \alpha b))(2wt + b(c - \alpha b)) - \delta b(4wt + 3b(c - \alpha b))}. \tag{18}$$

For this equilibrium to exist, the cost difference cannot be too high. More specifically, we require

$$\delta < \overline{\delta} = \frac{(b(c - \alpha b) + 2wt)\, 3b(c - \alpha b) + 2wt}{b(3b(c - \alpha b) + 4wt)}. \tag{19}$$

Comparing (17) and (18), we have

$$q_1^{AN} - q_1^{BN} = q_2^{BN} - q_2^{AN} = \frac{\left(pb^2 + 2wt^2\right)\delta}{(2wt + 3b(c - \alpha b))(2wt + b(c - \alpha b)) - \delta b(4wt + 3b(c - \alpha b))} > 0. \tag{20}$$

Thus, in equilibrium each provider offers higher quality of the service for which the provider has a cost advantage. As a result, Provider A1 has more than half of the market for Service A, whereas Provider B2 has more than half of the market for Service B.$q_1^{BI} - q_2^{BN}$

Under *integrated care*, the equilibrium qualities are given by

$$q_1^{AI} = q_2^{BI} = \frac{4w(pb - t(c - \alpha b)) + \delta(4wt + b(c - \alpha b))}{2w(4wt + 2b(c - \alpha b) - \delta b)} \tag{21}$$

$$q_1^{BI} = q_2^{AI} = \frac{4w(pb - t(c - \alpha b)) - \delta b(c - \alpha b - \delta)}{2w(4wt + 2b(c - \alpha b) - \delta b)}. \tag{22}$$

It is easily confirmed that $\delta < \overline{\delta}$ is a sufficient condition for equilibrium existence. Furthermore, and interior solution requires the condition

$$p > \overline{p} := \frac{4wt(c - \alpha b) + \delta b(c - \delta - \alpha b)}{4bw}. \tag{23}$$

Notice that $p > \overline{p}$ is a sufficient condition to ensure an interior solution also in the equilibrium without integration. Comparing (21) and (22), the quality differences in the Nash equilibrium under integrated care are given by

$$q_1^{AI} - q_1^{BI} = q_2^{BI} - q_2^{AI} = \frac{\delta}{2w} > 0. \tag{24}$$

Once more, each provider chooses a higher level of quality of the service for which the provider has a cost advantage. However, since $q_1^{AI} - q_1^{BI} = q_2^{BI} - q_2^{AI}$, the equilibrium demand for each provider under integrated care is exactly one half. Thus, under provider cost asymmetries, integrated care implies that some patients switch provider. More specifically, all the patients who choose different providers for the two services under non-integration must necessarily switch provider for one of the services when these services are integrated. With our particular assumptions, each provider serves half of these patients under integrated care. The effect of care integration on equilibrium demand is illustrated in Figure 1.

[Figure 1 here]

6.2.1 The effect of integrated care on quality provision

By a comparison of (17)-(18) and (21)-(22), we can characterise the effects of integrated care on equilibrium quality provision for each service as follows:

Proposition 5 *Suppose that the providers have a cost advantage in the provision of quality for different services. In this case there exists two threshold values of the per-unit price of services, given by $p_H > p_L$, such that:*

(i) If $p < p_L$, integrated care leads to a quality increase (reduction) for services with lower (higher) cost of quality provision, thus quality dispersion across the services offered by each provider.

(ii) If $p_L < p < p_H$, integrated care leads to a quality reduction for all services offered by all providers.

(iii) If $p > p_H$, integrated care leads to a quality reduction (increase) for services with lower (higher) cost of quality provision, thus quality convergence across the services offered by each provider.

These results, and the intuition behind them, are very similar to Proposition 1, based on cost differences between services. With our specific assumptions on cost differences across providers, where each provider has a cost advantage for a different service, integrated care implies an integration of two services with different costs of quality provision, which leads to quality changes caused by effect II. As explained in relation to Proposition 1, quality goes up (down) for the high-quality (low-quality) service if the per-unit price is sufficiently low, and *vice versa* if the price is sufficiently high.

However, with cost asymmetries across providers, there is an additional impact of integrated care caused by effect III. In the non-integrated equilibrium, the providers of the low-cost/high-quality services have higher market shares than the providers of the high-cost/low-quality services. All else equal, this implies that the former type of providers have higher marginal cost of quality provision than the latter. After integration, however, the market is equally split between the two integrated providers because of symmetry (each provider offers one high-quality and one low-quality service). Thus, integration implies an increase (reduction) in the marginal cost of quality provision for the high-quality (low-quality) service through effect III. All else equal, this increases (reduces) the scope for a quality increase of the high-quality (low-quality) service, which implies that the threshold values of p, above which integration leads to a quality reduction (increase) for the high-quality (low-quality) service, go up. The increase in the critical price level is higher for the high-cost/low-quality service, though. This implies, interestingly, that there is an intermediate range of prices, given by $p_L < p < p_H$, for which integrated care leads to a reduction in the quality of all services offered in the market.

6.2.2 The effect of integrated care on patients' health benefits

With provider asymmetry, the health effects of integration are harder to characterise, since the effects are not identical across all patients. There are essentially two relevant groups of patients (see Figure 1): (i) the 'stayers', who choose the same providers for both services with or without integrated care, and (ii) the 'switchers', who choose a different provider for each of the two services under non-integration and therefore have to switch provider for one of the services under integrated care.

Consider first the effect of integrated care on the health benefits of the *stayers*, and define $\Delta q_i^k := q_i^{kI} - q_i^{kN}$ as the change in quality of Service k by Provider i as a result of integrated care. Under our specific assumptions, which imply that $\Delta q_1^A = \Delta q_2^B$ and $\Delta q_1^B = \Delta q_2^A$, this effect is the same for all patients who stay with the same providers before and after integration, and is given by

$$\Delta H_{stayers} = b\left(\Delta q_1^A + \Delta q_1^B\right) = b\left(\Delta q_2^A + \Delta q_2^B\right). \tag{25}$$

The other group of patients are those who switch provider for one of the services as a result of integration. Notice that all switchers choose to receive Service A from Provider A1 and Service B from Provider B2 under non-integration. But this group of patients consists of two subgroups; those who choose Provider 1 and those who choose Provider 2, respectively, under integrated care. However, under our specific assumptions, where $\Delta q_1^A = \Delta q_2^B$, $q_1^{AN} = q_2^{BN}$ and $q_1^{BI} = q_2^{AI}$, the effect of integrated care on health benefits is the same for all patients across both subgroups. The change in health benefit for the *switchers* is therefore given by

$$\Delta H_{switchers} = b\left(\Delta q_1^A + q_1^{BI} - q_2^{BN}\right) = b\left(\Delta q_2^B + q_2^{AI} - q_1^{AN}\right). \tag{26}$$

Proposition 6 *Suppose that each provider has a cost advantage in the provision of quality for different service. In this case, integrated care has the following effects on patients' health benefit:*

(i) If $p > p_L$, where p_L is defined as in Proposition 5, the effect is negative for all patients.

(ii) If $p < p_L$, the effect is generally ambiguous, but negative for all patients if the degree of provider altruism is sufficiently high. The scope for a positive health benefit of integrated care is smaller for switchers than for stayers.

For the range of prices where integrated care leads to a quality reduction for all services (cf. Proposition 5), patients' health benefit obviously also goes down. This happens if $p_L < p < p_H$. However, integrated care reduce patients' health benefits also if $p > p_H$. In line with the results in Propositions 1-4, based on various types of asymmetries across services, patients can potentially benefit from integrated care only if integration leads to quality *dispersion* across the services offered by each provider. In this case, which requires $p < p_L$, a positive effect of integration is more likely for *stayers* than for *switchers*. This is quite intuitive, since, for the latter group of patients, integrated care implies a switch from two high-quality services (at different providers) to one high-quality and one low-quality service (at the same provider). Thus, these patients benefit from integration only if the replacement of a high-quality service with a low-quality service is more than compensated by a quality increase for the remaining high-quality service.

The results presented in Propositions 5 and 6 are summarised in Table 2.

[Table 2 here]

7 Welfare

In this section, we investigate the welfare implications of moving towards integrated care. We define welfare as the difference between patient benefits and provider costs. Assume, without loss of generality, that $q_1^{AN} \geq q_1^{BN}$, so that $D_1^A \geq D_1^B$ under non-integrated care. Welfare is then is given by

$$\begin{aligned} W^N(A1, A2, B1, B2) \quad = \quad & \int_0^{D_1^B} V^N(x, A1, B1)\, dx + \int_{D_1^B}^{D_1^A} V^N(x, A1, B2)\, dx + \int_{D_1^A}^{1} V^N(x, A2, B2)\, dx \\ & -c_1^A q_1^{AN} D_1^A - \frac{w}{2}\left(q_1^{AN}\right)^2 - c_1^B q_1^{BN} D_1^B - \frac{w}{2}\left(q_1^{BN}\right)^2 \\ & -c_2^A q_2^{AN}(1 - D_1^A) - \frac{w}{2}\left(q_2^{AN}\right)^2 - c_2^B q_2^{BN}(1 - D_1^B) - \frac{w}{2}\left(q_2^{BN}\right)^2. \end{aligned} \tag{27}$$

Instead, under integrated care, welfare is given by

$$\begin{aligned} W^I(A1, A2, B1, B2) \quad = \quad & \int_0^{D_1} V^I(x, A1, B1)\, dx + \int_{D_1}^{1} V^I(x, A2, B2)\, dx \\ & -c_1^A q_1^{AI} D_1 - \frac{w}{2}\left(q_1^{AI}\right)^2 - c_1^B q_1^{BI} D_1 - \frac{w}{2}\left(q_1^{BI}\right)^2 \\ & -c_2^A q_2^{AI}(1 - D_1) - \frac{w}{2}\left(q_2^{AI}\right)^2 - c_2^B q_2^{BI}(1 - D_1) - \frac{w}{2}\left(q_2^{BI}\right)^2. \end{aligned} \tag{28}$$

We denote the effect of integration on social welfare by $\Delta^W := W^I - W^N$. The total effect can be decomposed into four sub-effects and therefore expressed as

$$\Delta^W = \Delta^H - \Delta^T - \Delta^{VC} - \Delta^{FC}. \tag{29}$$

In order to facilitate the subsequent analysis of decomposition, we make the additional assumption that $D_1^A \geq D_1 \geq D_1^B$. This assumption encompasses the special case analysed in Section 5.2, where $D_1 = 1/2$ and $D_1^B = 1 - D_1^A < 1/2$.

The effect of integration on *aggregate patient utility* is given by the first two terms in (29),

$\Delta^H - \Delta^T$. The first term is the effect on *patients' health benefits*, given by

$$\begin{aligned}\Delta^H \quad : \quad &= D_1^B \sum_{k=A.B} b_k \Delta q_1^k + (1-D_1^A) \sum_{k=A.B} b_k \Delta q_2^k \\ &+ (D_1 - D_1^B) \left[b_A \Delta q_1^A + b_B \left(q_1^{BI} - q_2^{BN} \right) \right] \\ &+ (D_1^A - D_1) \left[b_A \left(q_2^{AI} - q_1^{AN} \right) + b_B \Delta q_2^B \right].\end{aligned} \tag{30}$$

The four terms in (30) measure the health effect for four different groups of patients. The first two groups of patients are served by the same providers under both integrated and non-integrated care. The first group involves D_1^B patients who choose providers $A1$ and $B1$ before and after integration, and the second group involves $(1 - D_1^A)$ patients who choose providers $A2$ and $B2$ before and after integration. The third group involves $(D_1 - D_1^B)$ patients. These patients are served by providers $A1$ and $B1$ under integrated care but are served by providers $A1$ and $B2$ when care is not integrated. Similarly, the fourth group involves $(D_1^A - D_1)$ patients. These patients are served by providers $A2$ and $B2$ under integrated care but are served by providers $A1$ and $B2$ when care is not integrated. The aggregate health effect of integration is therefore given by the sum of the health effects for the 'stayers' (first and second term) and for the 'switchers' (third and fourth term). These effects have already been characterised in Section 5 and are therefore not repeated here.

The second term in (29) is the effect of integration on *aggregate mismatch costs*, given by

$$\Delta^T = \sum_{k=A,B} t_k \left[D_1^k \left(1 - D_1^k \right) - D_1 \left(1 - D_1 \right) \right]. \tag{31}$$

Since mismatch costs are the same before and after integration for all the stayers, integration affects aggregate mismatch costs only through the behaviour of those patients who change provider. Thus, Δ^T is given by the change in mismatch costs for those patients who switch from Provider $A1$ to Provider $A2$ as a result of integration, plus the change in mismatch costs for those patients who switch from $B2$ to $B1$. We see from (31) that integration leads to a reduction in aggregate mismatch costs associated with the use of Service k if D_1 is closer to the midpoint of the unit line than D_1^k is. In our analysis in Section 5.2, where $D_1 = 1/2$, this is true for both services. More generally, since aggregate mismatch costs are miminised when each provider serves half of the market, integrated care leads to a reduction in mismatch costs if the indifferent patient in the post-integration equilibrium is located sufficiently close to the midpoint of the unit line.

The third and fourth terms in (29) measure the effect of integration on the total cost of providing the two services. The third term is the effect on *variable costs of service provision*, which is given by

$$\begin{aligned}\Delta^{VC} &= D_1^B \sum_{k=A.B} c_1^k \Delta q_1^k + (1 - D_1^A) \sum_{k=A.B} c_2^k \Delta q_2^k \\ &+ (D_1 - D_1^B) \left[c_1^A \Delta q_1^A + c_1^B q_1^{BI} - c_2^B q_2^{BN} \right] \\ &+ (D_1^A - D_1) \left[c_2^A q_2^{AI} - c_1^A q_1^{AN} + b_B \Delta q_2^B \right].\end{aligned} \tag{32}$$

As for the health benefits of integration, changes in the variable costs of service provision can be decomposed into cost changes associated with four different groups of patients, two types of stayers and two types of switchers. For the patients who do not switch provider (i.e., the stayers), changes in variable provision costs are only caused by changes in quality provision, where an increase in quality also increases the variable cost of service provision. However, for the switchers, there are additional allocational cost effects related to patients switching between providers with different provision costs. For example, if $c_1^A < c_2^A$ and $c_1^B > c_2^B$, as in the case considered in Section 5.2, integration implies that some patients switch from a more efficient provider to a less efficient provider for each of the two services, which all else equal implies an efficiency loss. This illustrates a more general point. Since integrated care by its nature involves a restriction on patient choice, integration of services might lead to allocational cost inefficiencies if the integrated providers are relatively cost efficient in the provision of some services but relatively cost inefficient in the provision of others.

The fourth and final term in (29) measures the change in the fixed costs of quality provision caused by integration, and is given by

$$\Delta^{FC} = \frac{w}{2} \sum_{i=1,2} \sum_{k=A,B} \left[\left(q_i^{kI} \right)^2 - \left(q_i^{kN} \right)^2 \right]. \tag{33}$$

Since these costs are fixed and therefore do not depend on demand allocations, the effect of integration on these costs is solely determined by the effect of integration on quality provision. If integration leads to higher quality provision for a particular service, there is a corresponding cost increase.

Clearly, the sum of the four above described welfare effects of integration has an *a priori* indeterminate sign, and further insights cannot be gleaned without imposing more structure on the model. Thus, to further characterise the potential welfare trade-offs involved when moving towards integrated care, suppose that the cost of quality provision for each service is the same for both providers, $c_1^k = c_2^k = c^k$, which implies $q_1^{kj} = q_2^{kj} = q^{kj}$, for $j = N, I$, and $D_1 = D_1^A = D_1^B = 1/2$. The different welfare effects of integration then reduce to

$$\Delta^H = \sum_{k=A.B} b_k \Delta q^k, \quad \Delta^T = 0, \quad \Delta^{VC} = \sum_{k=A.B} c^k \Delta q^k, \quad \Delta^{FC} = w \sum_{k=A,B} \left[\left(q^{kI}\right)^2 - \left(q^{kN}\right)^2 \right], \tag{34}$$

and the overall welfare effect can be expressed as

$$\Delta^W = \sum_{k=A,B} \left[b_k - c^k - w\left(q^{kI} + q^{kN}\right) \right] \Delta q^k. \tag{35}$$

When integration does not lead any patient to switch provider, there are no costs or gains related to mismatch costs or allocational cost efficiency. In this case, whether integration is welfare improving or not depends on (i) whether the quality of each service increases or decreases, which is given by the sign of Δq^k, and (ii) whether the marginal net benefit of quality provision for each service is above or below the additional fixed costs incurred by a marginal quality improvement (evaluated at the average quality between integrated and non-integrated care), which determines the sign of the expression in square brackets in (35).

A number of configurations are possible. Consider for example the case analysed in Section 5.1.3, in which Service A has a higher demand responsiveness to quality, $t^A < t^B$, but services do not differ in production costs, marginal benefits of quality or price, i.e., $c_A = c_B = c$, $b_A = b_B = b$ and $p_A = p_B = p$. In this case, which implies $q^{AI} = q^{BI} = q^I$ and $q^{AN} > q^I > q^{BN}$, the welfare effect of integration can be expressed as

$$\Delta^W = (b - c)\left(2q^I - q^{AN} - q^{BN}\right) - w\left(2\left(q^I\right)^2 - \left(q^{AN}\right)^2 - \left(q^{BN}\right)^2\right). \tag{36}$$

From Proposition 3 we know that q^I is smaller than the mean of $\left(q^{AN}, q^{BN}\right)$, which in turn implies that q^I is also smaller than the root mean square of $\left(q^{AN}, q^{BN}\right)$. This means that the first term in (36) is negative while the second is positive. In other words, whereas integration leads to a reduction in average health benefits for patients (net of variable provision costs), it also leads to a reduction in the fixed costs of quality provision. Whether or not the effect of lower quality costs outweighs the effect of lower health benefits depends on whether quality is over- or underprovided to begin with. This depends in turn on the price level, p. By evaluating (36) at the equilibrium values of q^I, q^{AN} and q^{BN}, it is relatively straightforward to verify that Δ^W is positive (negative) if p is above (below) a certain threshold level. Thus, if p is sufficiently high so that quality is overprovided from a welfare perspective, integration can increase welfare despite the reduction in patients' health benefits, because this is more than outweighed by the reduction in fixed quality provision costs.

8 Synergies

In the main analysis of this paper we have focused on the effects of integrated care that are purely caused by strategic interaction between competing providers. However, there might also be various synergies or coordination gains related to the integration of different services. In this section we will briefly identify the potential synergies from care integration that can be identified and operationalised within our modelling framework, and show how each of these potential synergies might affect the quality of care.

Whereas the existence of strategic effects of integration requires asymmetries across services and/or providers, this is naturally not the case for synergy effects. For simplicity, we will therefore concentrate on the fully symmetric case, where $b_A = b_B = b$, $t_A = t_B = t$, $p_A = p_B = p$ and $c_1^A = c_2^A = c_1^B = c_2^B = c$, which means that equilibrium quality is equal with and without integration in the absence of synergies.

Suppose, though, that integration of care leads to some (exogenous) synergies. Such synergies can in principle apply both to the benefits and costs of care service provision. Within our framework we can identify three different sources of potential synergies:

1. Integration could lead to synergies in health benefits due to improved patient pathways. We model this as the marginal benefit of care service quality being given by $b(1+\theta_b)$ after integration, where $\theta_b > 0$ measures the magnitude of the synergy.

2. Integration could lead to reduction in provider costs, for example due to avoidance of duplication of patient visits. We model this as the providers' variable cost parameter being given by $c(1-\theta_c)$ after integration, where $\theta_c \in (0,1)$ measures the magnitude of this cost synergy.

3. Integration could also potentially lead to a reduction in patients' mismatch costs. If these costs include physical transportation costs, they can be reduced by integration simply by

allowing for double appointments, which reduces the amount of travelling needed. We model this as the marginal transportation cost being given by $t(1-\theta_t)$ after integration, where $\theta_t \in (0,1)$ measures the magnitude of this particular synergy.

With the above described synergies, equilibrium quality of Service k after integration is given by

$$q^{kI} = \frac{pb(1+\theta_b) - t(1-\theta_t)(c(1-\theta_c) - \alpha b(1+\theta_b))}{2wt(1-\theta_t) + b(1+\theta_b)(c(1-\theta_c) - \alpha b(1+\theta_b))}. \quad (37)$$

Under full symmetry, we know that $\Delta q^k := q^{kI} - q^{kN} = 0$ in the absence of synergies. We can therefore assess the effect of integration on quality in the presence of synergies by considering the effect of a marginal increase in θ_m, evaluated at $\theta_m = 0$, for $m = b, t, c$. This yields:

$$\left.\frac{\partial \Delta q^k}{\partial \theta_b}\right|_{\theta_b=\theta_t=\theta_c=0} = \left.\frac{\partial q^{kI}}{\partial \theta_b}\right|_{\theta_b=\theta_t=\theta_c=0} = b\frac{2tw(p+\alpha t) + \alpha b^2 p + t(c-\alpha b)^2}{(2tw + b(c-\alpha b))^2} > 0, \quad (38)$$

$$\left.\frac{\partial \Delta q^k}{\partial \theta_t}\right|_{\theta_b=\theta_t=\theta_c=0} = \left.\frac{\partial q^{kI}}{\partial \theta_t}\right|_{\theta_b=\theta_t=\theta_c=0} = bt\frac{2pw + (c-\alpha b)^2}{(2tw + b(c-\alpha b))^2} > 0, \quad (39)$$

$$\left.\frac{\partial \Delta q^k}{\partial \theta_c}\right|_{\theta_b=\theta_t=\theta_c=0} = \left.\frac{\partial q^{kI}}{\partial \theta_c}\right|_{\theta_b=\theta_t=\theta_c=0} = \frac{\left(pb^2 + 2wt^2\right)c}{(2tw + b(c-\alpha b))^2} > 0. \quad (40)$$

As expected, each of the three suggested synergies contributes to a positive effect of care integration on equilibrium quality provision, and in each case the intuition is straightforward. If integration increases patients' marginal benefit of quality ($\theta_b > 0$), each provider will face a more quality elastic demand. The same occurs if integration reduces patients' marginal transportation costs ($\theta_t > 0$). In both cases, care integration intensifies competition between providers and leads to higher quality provision in equilibrium. The mechanism is slightly different if the synergies are related to the cost of provision ($\theta_c > 0$), but the outcome is ultimately the same. If integration reduces the marginal cost of quality provision, equilibrium quality will be higher in the post-integration equilibrium.

9 Conclusions

Policy makers in many countries are promoting integrated care to improve quality and deal with an aging population with a complex set of health problems and thus in need of multiple treatments from different types of providers both within and beyond the health sector. The push for integrated care comes potentially at the expense of reduced competition among health care providers. A recent example is the UK government's white paper in February 2021 proposing to substitute competition and the internal market to facilitate integration of health and social care provision.[10]

Despite the policy trend towards more integrated care, the economic research on the effects of integrated care on treatment quality and health benefits to patients is limited. Our paper provides a theoretical framework for understanding the key mechanisms at work. We show that the effect of integration on quality of care is generally ambiguous with the net effect being driven by two key mechanisms. First, under integrated care, demand responds less to an increase in the quality of a particular service simply because the quality of a single service is of relatively less importance when patients choose between 'packages' containing more than one service. All else equal, this effect pulls in the direction of *weaker* incentives for quality provision as a result of integration. Second, since the patients demand two services from the same provider under integrated care, each extra patient is more valuable to the provider, i.e., the marginal net benefit of attracting more patients is larger under integrated care. All else equal, this effect pulls in the direction of *stronger* incentives for quality provision as a result of integration.[11] In the special case of symmetry, the two counteracting effects exactly cancel out, implying that integration has no (positive or negative) effect on the quality of care.

In the presence of asymmetries across services, driven by differences in costs, prices, demand elasticities and patient benefits, a key finding is that integration in most cases leads to an increase in quality for one type of service and a reduction for the other. Whether this results in quality convergence or dispersion across the services following integration depends on the type of asymmetry. We show that quality convergence arises in the presence of differences in prices and demand responsiveness due to transportation costs, but both convergence or dispersion can arise in the presence of differences in costs and valuations of quality across services (cf. Table 1). Perhaps counterintuitively, we show that patients tend to experience a health loss if integration leads to quality convergence across services, so that the health loss from the reduction in quality in one service dominates over the health gain from the increase in quality from the other service. Conversely, an increase in health benefits arises if integration leads to quality dispersion.

Extending the model with asymmetries across providers allows us to investigate the differential

[10] See the policy paper "Integration and innovation: working together to improve health and social care for all" from the UK Department of Health & Social Care dated 11 February 2021.

[11] In addition, since providers is likely to face different demand for a given service under integrated and unintegrated care, the marginal cost of quality provision will also be affected and may reinforce or weaken the incentives for quality provision.

effects of integration on those patients who stay with the same provider following integration, and those who switch provider. We show that it is still the case that when integration leads to quality convergence the health benefits of the patients are reduced for both stayers and switchers, while the effect on health benefits is indeterminate when integration leads to quality dispersion (cf. Table 2). In an extension, we also allow for integration to involve synergies on either the cost side or on the patient benefit side. As intuitively expected, synergies makes integration more favourable as it increases incentives for quality and improves patients' health benefits.

In terms of policy implications, our study shows that, lacking any significant synergies, the impact of integrated care on service quality and in turn patient welfare is far from straightforward. The model highlights that policies that encourage competition are not necessarily in contrast with policies that encourage integration because providers can still compete on quality for integrated care packages. We show indeed that competition under integration can lead in some scenarios to health improvements even in the absence of synergies on benefits and costs. Integrating providers however does restrict patient choice, as our analysis of stayers and switchers clearly shows, forcing some patients to attend the same organisation for both services while they would have chosen different ones without integration. One policy option is to assess integrated care policies based on a case-by-case evaluation of the services that is considered for integration.

By way of conclusion, we would like to mention two limitations. First, we have compared a fully non-integrated scheme with a fully integrated scheme, and disregarded a mixed scheme with both integrated providers and non-integrated providers. Our model is already quite rich and the computations fairly involved, so adding another asymmetry to our analysis would make computations and results more complicated without necessarily generating additional insights within the current set-up. Thus, we leave the mixed scenario to future research. Second, we have allowed for some degree of competition also in the integrated care set up, as patients still can choose between the service bundles offered by the different providers. This seems the most realistic scenario, as patient choice is likely to be retained in the future. Although less likely, integrated care could be modelled as potentially involving a 'monopolisation' of the care provision, eliminating patient choice and competition completely, though such a model is likely to predict a reduction in quality.

Appendix

Proof of Proposition 1

Using (12) and (13), with $p_A = p_B = p$, $t_A = t_B = t$ and $b_A = b_B = b$, the effect of integrated care on the quality of Service k is given by

$$\Delta q^k = \frac{b\left(c^k - c^{-k}\right)\Upsilon}{2w\left(2wt + b\left(c^k - \alpha b\right)\right)\left(4wt + b\left(c^k + c^{-k} - 2\alpha b\right)\right)}, \tag{A1}$$

where

$$\Upsilon := 2w\left(\left(p + 2\alpha t\right)b - \left(c^k + c^{-k}\right)t\right) - b\left(c^k - \alpha b\right)\left(c^{-k} - \alpha b\right). \tag{A2}$$

Using (A1) and (14), the effect of integrated care on patients' health benefit is given by

$$\Delta H = -\frac{b^3\left(c^k - c^{-k}\right)^2\Upsilon}{2w\left(2wt + b\left(c^k - \alpha b\right)\right)\left(2wt + b\left(c^{-k} - \alpha b\right)\right)\left(4wt + b\left(c^k + c^{-k} - 2\alpha b\right)\right)}. \tag{A3}$$

From (A2) it follows that

$$\Upsilon > (<)\, 0 \text{ if } p > (<)\, \widehat{p} := \frac{2w\left(t\left(c^k + c^{-k}\right) - 2\alpha bt\right) + b\left(c^k - \alpha b\right)\left(c^{-k} - \alpha b\right)}{2bw}. \tag{A4}$$

Notice that $\widehat{p}$ is higher than the price level needed to ensure an interior solution; i.e., $q^k > 0$ with and without integration for $p = \widehat{p}$. Given (A4), the results in the proposition then follows directly from an inspection of (A1) and (A3). *Q.E.D.*

Proof of Proposition 2

Using (12) and (13), with $c^A = c^B = c$, $t_A = t_B = t$ and $b_A = b_B = b$, the effect of integrated care on the quality of Service k is given by

$$\Delta q^k = \frac{b\left(p_{-k} - p_k\right)}{2\left(2wt + b\left(c - \alpha b\right)\right)} < (>)\, 0 \text{ if } p_k > (<)\, p_{-k}. \tag{A5}$$

Since $\Delta q^k = -\Delta q^{-k}$ and $b_A = b_B = b$, it follows that $\Delta H = 0$. *Q.E.D.*

Proof of Proposition 3

Using (12) and (13), with $c^A = c^B = c$, $p_A = p_B = p$ and $b_A = b_B = b$, the effect of integrated care on the quality of Service k is given by

$$\Delta q^k = \frac{b\left(t_k - t_{-k}\right)\left[2pw + (c - \alpha b)^2\right]}{2\left(2kw + b\left(c - \alpha b\right)\right)\left(w\left(t_k + t_{-k}\right) + b\left(c - \alpha b\right)\right)} > (<)\, 0 \text{ if } t_k > (<)\, t_{-k}. \tag{A6}$$

Using (A6) and (14), the effect of integrated care on patients' health benefit is given by

$$\Delta H = -\frac{wb^2\left(2pw + (c - \alpha b)^2\right)\left(t_k - t_{-k}\right)^2}{\left(2wt_k + b\left(c - \alpha b\right)\right)\left(2wt_{-k} + b\left(c - \alpha b\right)\right)\left(k\left(t_k + t_{-k}\right) + b\left(c - b\alpha\right)\right)} < 0. \tag{A7}$$

Q.E.D.

Proof of Proposition 4

Using (12) and (13), with $c^A = c^B = c$, $p_A = p_B = p$ and $t_A = t_B = t$, the effect of integrated care on the quality of Service k is given by

$$\Delta q^k = \frac{b\left(b_k - b_{-k}\right)\Theta}{2w\left(2wt + b_k\left(c - \alpha b_k\right)\right)\left(4wt + \sum_{s=A,B} b_s\left(c - \alpha b_s\right)\right)}, \tag{A8}$$

where

$$\Theta := \left(2w\left(\left(p + \alpha t\right)\left(c - \alpha\left(b_k + b_{-k}\right)\right) + \alpha ct\right) + c\left(c - \alpha b_k\right)\left(c - \alpha b_{-k}\right)\right). \tag{A9}$$

Using (A8) and (14), the effect of integrated care on patients' health benefit is given by

$$\Delta H = \frac{\left(b_k - b_{-k}\right)^2\left[2wt\left(b_k + b_{-k}\right) + b_k b_{-k} c\right]\Theta}{2w\left(2wt + b_{-k}\left(c - \alpha b_{-k}\right)\right)\left(2wt + b_k\left(c - \alpha b_k\right)\right)\left(4wt + \sum_{s=A,B} b_s\left(c - \alpha b_s\right)\right)}. \tag{A10}$$

Notice first that $\Theta > 0$ if $\alpha < c/\left(b_k + b_{-k}\right)$. Suppose instead that $\alpha \in \left(c/\left(b_k + b_{-k}\right), \min\left\{c/b_k, c/b_{-k}\right\}\right)$, which makes the sign of Θ *a priori* indeterminate. From (A9) we derive

$$\frac{\partial \Theta}{\partial \alpha} = -\left(w\left(2p + 4\alpha t\right) + c^2\right)\left(b_k + b_{-k}\right) + 2c\left(2wt + \alpha b_k b_{-k}\right), \tag{A11}$$

which is negative for $\alpha \in \left(c/\left(b_k + b_{-k}\right), \min\left\{c/b_k, c/b_{-k}\right\}\right)$. Thus, Θ is potentially negative if α is sufficiently high. Suppose that $b_k > b_{-k}$, which implies that the upper bound on α is

c/b_{-k}. Setting $\alpha = c/b_{-k}$ in (A9) yields $\Theta = -2wc\left(pb_k b_{-k} + ct\left(b_k - b_{-k}\right)\right)/b_{-k}^2 < 0$. By symmetry, an equivalent result holds for $b_k < b_{-k}$. Thus, $\Theta > (<)\,0$ if $\alpha > (<)\,\widehat{\alpha}$, where $\widehat{\alpha} \in \left(c/\left(b_k + b_{-k}\right), \min\left\{c/b_k, c/b_{-k}\right\}\right)$. The results in the proposition then follows directly from (A8) and (A10). *Q.E.D.*

Proof of Proposition 5

Define $\Delta q_i^k := q_i^{kI} - q_i^{kN}$ as the change in quality of Service k by Provider i as a result of integrated care. Comparing (17)-(18) and (21)-(22), the effects of integrated care on the quality provision for each service are then given by

$$\Delta q_1^A = \Delta q_2^B = -\frac{\delta b\left[\left(2wt + b\left(c - \alpha b\right)\right)\left(2pwb - \left(c - \alpha b\right)\left(8wt + 3b\left(c - \alpha b\right)\right)\right) + \delta\theta_1\right]}{2w\left(4wt + 2b\left(c - \alpha b\right) - \delta b\right)\Psi}, \tag{A12}$$

$$\Delta q_1^B = \Delta q_2^A = \frac{\delta b\left[\left(2wt + b\left(c - \alpha b\right)\right)\left(2pwb - \left(c - \alpha b\right)\left(8wt + 3b\left(c - \alpha b\right)\right)\right) + \delta\theta_2\right]}{2w\left(4wt + 2b\left(c - \alpha b\right) - \delta b\right)\Psi} \tag{A13}$$

where

$$\theta_1 := 3b^2\left(c - \alpha b\right)^2 + k\left(2pb^2 + 2t\left(6wt + 5b\left(c - \alpha b\right)\right)\right), \tag{A14}$$

$$\theta_2 := 3b\left(c - \alpha b\right)\left(2\left(3wt + b\left(c - \alpha b\right)\right) - \delta b\right) + 4w\left(t\left(wt - \delta b\right) - pb^2\right) \tag{A15}$$

and

$$\Psi := \left(2wt + 3b\left(c - \alpha b\right)\right)\left(2wt + b\left(c - \alpha b\right)\right) - \delta b\left(4wt + 3b\left(c - \alpha b\right)\right) > 0. \tag{A16}$$

The signs of (A12) and (A13) depend on the signs of the respective numerators. Let the expressions in the square brackets of the numerators in (A12) and (A13) be denoted by N_1 and N_2, respectively. These expressions depend on p as follows:

$$\frac{\partial N_1}{\partial p} = 2bw\left(2wt + b\left(c - \alpha b\right) + \delta b\right) > 0, \tag{A17}$$

$$\frac{\partial N_2}{\partial p} = 2bw\left(2wt + b\left(c - \alpha b\right) - 2\delta b\right) > 0. \tag{A18}$$

The positive sign of (A18) is confirmed by imposing the restriction $\delta < \overline{\delta}$. Thus, both N_1 and N_2 are monotonically increasing in p. Assume that both N_1 and N_2 switch sign for values of p higher than the lower bound $\overline{p}$. Solving $N_1 = 0$ and $N_2 = 0$, the candidate threshold values of p are given by, respectively,

$$p_1 = \frac{\left[\begin{array}{c}(c-\alpha b)(8wt+3b(c-\alpha b))(2wt+b(c-\alpha b)) \\ -\delta\left(3b^2(c-\alpha b)^2+2wt(6wt+5b(c-\alpha b))\right)\end{array}\right]}{2bw(2wt+b(c-\alpha b)+\delta b)} \tag{A19}$$

and

$$p_2 = \frac{\left[\begin{array}{c}(c-\alpha b)(8wt+3b(c-\alpha b))(2wt+b(c-\alpha b)) \\ -\delta(3b(c-\alpha b)(6wt+2b(c-\alpha b)-\delta b)+4wt(kt-\delta b))\end{array}\right]}{2bw(2wt+b(c-\alpha b)-2\delta b)}. \tag{A20}$$

It follows that $\Delta q_1^A = \Delta q_2^B > (<) \, 0$ if $p < (>) \, p_1$ and $\Delta q_1^B = \Delta q_1^A < (>) \, 0$ if $p < (>) \, p_2$. Comparing p_1 and p_2, we derive

$$p_2 - p_1 = \delta \frac{\left(4wt(wt+2b(c-\alpha b)-\delta b)+3b^2(c-\alpha b)(c-\delta-\alpha b)\right)(4wt+2b(c-\alpha b)-\delta b)}{2bw(2wt+b(c-\alpha b)-2\delta b)(2wt+b(c-\alpha b)+\delta b)}. \tag{A21}$$

The sign of this expression is given by the sign of the numerator, which we denote N_p. In order to determine the sign of N_p, notice first that

$$\frac{\partial N_p}{\partial \delta} = -b\left[(2wt+b(c-\alpha b))(10wt+9b(c-\alpha b))-2\delta b(4wt+3b(c-\alpha b))\right]. \tag{A22}$$

This expression is clearly negative for a sufficiently low value of δ, and the scope for a negative sign is smaller the higher δ. Setting δ at the upper bound $\delta = \overline{\delta}$, the expression in (A22) reduces to $-3b(2wt+b(c-\alpha b))^2 < 0$. Thus, $\partial N_p/\partial\delta < 0$ for all $\delta < \overline{\delta}$, which means that the numerator in (A21) is monotonically decreasing in δ. Setting $\delta = \overline{\delta}$ in (A21), it is easy to verify that the numerator in (A21) becomes zero (i.e., $N_p = 0$ if $\delta = \overline{\delta}$). Thus, $p_2 - p_1 > 0$ for all $\delta < \overline{\delta}$. It remains to prove that our initial assumption is true, namely that the threshold values p_1 and p_2 are higher than the lower bound on p. Given that $p_2 > p_1$, it suffices to show that $p_1 > \overline{p}$. Using (A19) and (23), we have

$$p_1 - \overline{p} = \frac{(c-\delta-\alpha b)(6wt+3b(c-\alpha b)+\delta b)(4wt+2b(c-\alpha b)-\delta b)}{4bw(2wt+b(c-\alpha b)+\delta b)} > 0. \tag{A23}$$

By relabeling p_1 and p_2 as p_L and p_H, respectively, the results in Proposition 5 follow. *Q.E.D.*

Proof of Proposition 6

Using (A12)-(A13) and (25), the effect of integrated care on the health benefit of *stayers* is given by

$$\Delta H_{stayers} = -\frac{\delta^2 b^2 \left[6pwb^2 + 8w^2t^2 - b\,(c-\alpha b)\,(8wt + 3b\,(c-\alpha b)) + \delta b\,(4wt + 3b\,(c-\alpha b))\right]}{2w\,(4wt + 2b\,(c-\alpha b) - \delta b)\,\Phi}, \tag{A24}$$

where

$$\Phi := (2wt + b\,(c-\alpha b))\,(2wt + 3b\,(c-\alpha b)) - \delta b\,(4wt + 3b\,(c-\alpha b)) > 0. \tag{A25}$$

The sign of (A24) depends on the sign of the expression in square brackets in the numerator. This expression is monotonically increasing in p and thus positive if p is sufficiently high. Assume that the expression switches sign at a threshold value $p_3 > \overline{p}$. Setting the expression in square brackets equal to zero and solving for p yields

$$p_3 = -\frac{\left(8w^2t^2 - b\,(c-\alpha b)\,(8wt + 3b\,(c-b\alpha)) + \delta b\,(4wt + 3b\,(c-\alpha b))\right)}{6wb^2}. \tag{A26}$$

A comparison of p_3 and $p_L\,(=p_1)$, given by (A19), yields

$$p_L - p_3 = \frac{(4wt + b\,(2\,(c-\alpha b) - \delta))\begin{pmatrix}(2wt + 3b\,(c-\alpha b))\,(2wt + b\,(c-\alpha b)) \\ -\delta b\,(4wt + 3b\,(c-\alpha b))\end{pmatrix}}{6wb^2\,(2wt + b\,(c-\alpha b + \delta))}. \tag{A27}$$

The sign of this expression depends on the sign of the second factor in the numerator, which is monotonically decreasing in δ. Evaluated at $\delta = \overline{\delta}$, it is easily confirmed that this factor is zero. Thus, $p_L > p_3$ for all $\delta < \overline{\delta}$.

A similar comparison of p_3 and the lower bound $\overline{p}$, given by (23), yields

$$\overline{p} - p_3 = \frac{[4kt + b\,(2\,(c-\alpha b) - \Delta)]\,[4kt - 3b\,(c - \Delta - \alpha b)]}{12kb^2}. \tag{A28}$$

The sign of this expression depends on the sign of the second factor in the numerator, which is positive if

$$\alpha > \alpha_1 := \frac{c-\delta}{b} - \frac{4wt}{3b^2}. \tag{A29}$$

Thus, if $\alpha > \alpha_1$, integrated care reduces the health benefit of *stayers* for all $p \geq \overline{p}$.

Using (A12)-(A13) and (26), the effect of integrated care on the health benefit of *switchers* is given by

$$\Delta H_{switchers} = -\frac{\delta b}{2}\frac{\left[\begin{array}{c} 4w\left(2wt+b\left(c-\alpha b\right)\right)\left(pb^2+2wt^2\right) \\ +\delta b\left(\begin{array}{c} 4w\left(pb^2+wt^2\right)+\delta b\left(4wt+3b\left(c-\alpha b\right)\right) \\ -b\left(c-\alpha b\right)\left(8wt+3b\left(c-\alpha b\right)\right) \end{array}\right) \end{array}\right]}{w\left(4wt+2b\left(c-\alpha b\right)-\delta b\right)\Phi}. \tag{A30}$$

The sign of this expression depends on the sign of the numerator, which is monotonically increasing in p and thus positive if p is sufficiently high. Assume that the numerator switches sign at a threshold value $p_4 > \overline{p}$. Setting the numerator equal to zero and solving for p yields

$$p_4 = -\frac{\left[\begin{array}{c} 8w^2t^2\left(b\left(c-\alpha b\right)+2wt\right) \\ +\delta b\left(4w^2t^2-b\left(c-\alpha b\right)\left(3b\left(c-\alpha b\right)+8wt\right)+\delta b\left(3b\left(c-\alpha b\right)+4wt\right)\right) \end{array}\right]}{4wb^2\left(\delta b+\left(b\left(c-\alpha b\right)+2wt\right)\right)}. \tag{A31}$$

A comparison of p_4 and p_L yields

$$p_L - p_4 = \frac{\left[\begin{array}{c} \left(2wt+3b\left(c-\alpha b\right)\right)\left(2wt+b\left(c-\alpha b\right)\right) \\ -\delta b\left(4wt+3b\left(c-\alpha b\right)\right) \end{array}\right]\left[4wt+b\left(2\left(c-\alpha b\right)-\delta\right)\right]}{4wb^2\left(2wt+b\left(c+\delta-\alpha b\right)\right)}. \tag{A32}$$

The sign of this expression depends on the sign of the first factor in the numerator, which is monotonically decreasing in δ. Evaluated at $\delta = \overline{\delta}$, it is easily confirmed that this factor is zero. Thus, $p_L > p_4$ for all $\delta < \overline{\delta}$.

A similar comparison of p_4 and the lower bound $\overline{p}$ yields

$$\overline{p} - p_4 = \left[2wt\left(2wt+b\left(c-\alpha b\right)\right)+\delta b\left(2wt-b\left(c-\delta-\alpha b\right)\right)\right]\frac{4wt+b\left(2\left(c-\alpha b\right)-\delta\right)}{4wb^2\left(2wt+b\left(c-\alpha b+\delta\right)\right)}. \tag{A33}$$

The sign of this expression depends on the sign of expression in square brackets. A sufficient (but not necessary condition for this expression to be positive is

$$\alpha > \alpha_2 := \frac{c-\delta}{b} - \frac{2tw}{b^2}. \tag{A34}$$

Thus, if $\alpha > \alpha_2$, integrated care reduces the health benefit of *switchers* for all $p \geq \overline{p}$. Furthermore, since $\alpha_2 < \alpha_1$, the scope for a positive health benefit of integrated care (when $p < p_L$) is smaller for *switchers* than for *stayers*. *Q.E.D.*

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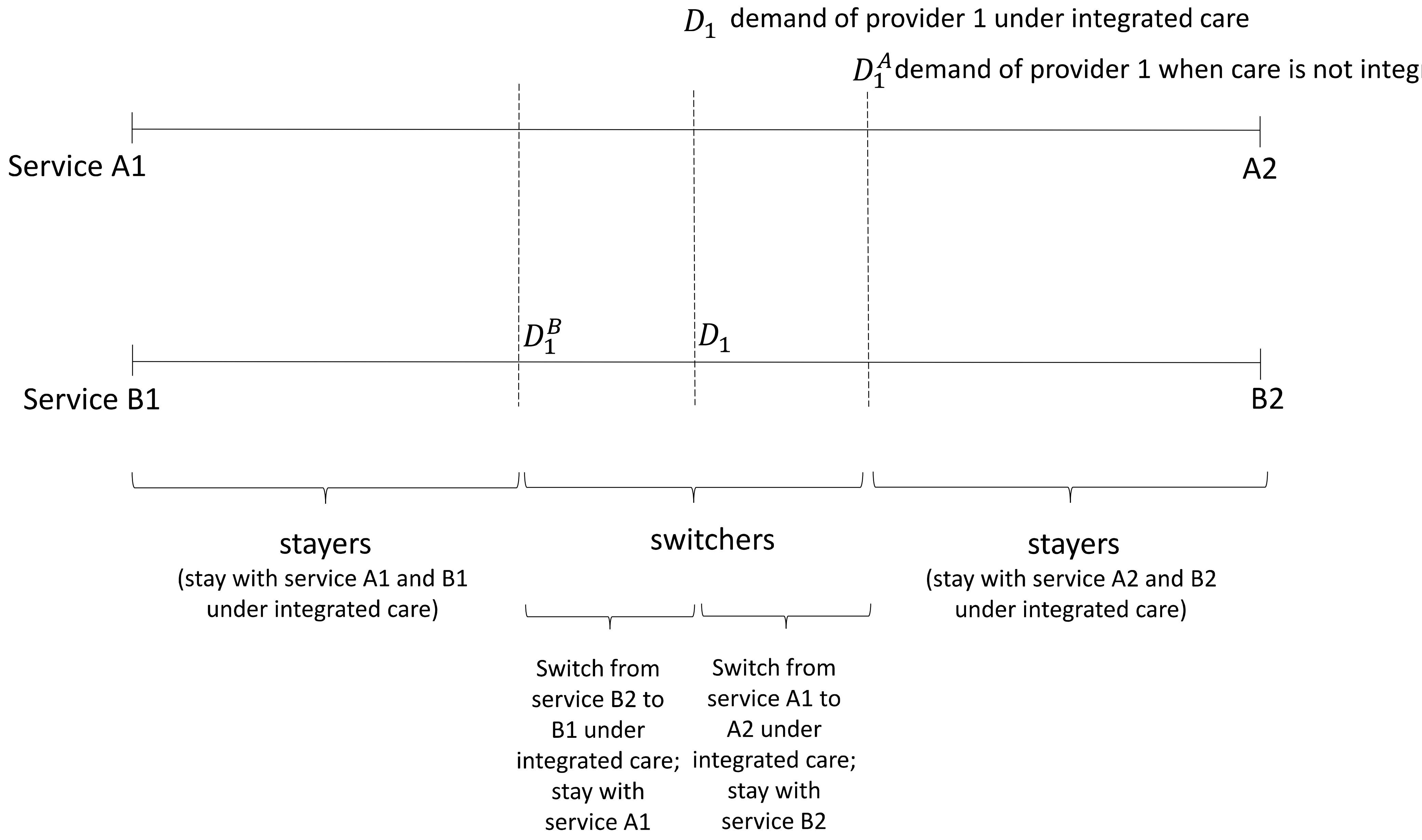
Table 1. Asymmetries across services

Parameter regime	No integration	Effects of integration on quality	Health effect
$c^A < c^B$ & $p < \widehat{p}$	$q^{AN} > q^{BN}$	$\Delta q^A > 0; \Delta q^B < 0$ (dispersion)	$\Delta H > 0$
$c^A < c^B$ & $p > \widehat{p}$	$q^{AN} > q^{BN}$	$\Delta q^A < 0; \Delta q^B > 0$ (convergence)	$\Delta H < 0$
$p^A > p^B$	$q^{AN} > q^{BN}$	$\Delta q^A < 0; \Delta q^B > 0$ (convergence)	$\Delta H = 0$
$t^A < t^B$	$q^{AN} > q^{BN}$	$\Delta q^A < 0; \Delta q^B > 0$ (convergence)	$\Delta H < 0$
$b^A > b^B$ & $\alpha < \widehat{\alpha}$	$q^{AN} > q^{BN}$	$\Delta q^A > 0; \Delta q^B < 0$ (dispersion)	$\Delta H > 0$
$b^A > b^B$ & $\alpha > \widehat{\alpha}$	$q^{AN} > q^{BN}$	$\Delta q^A < 0; \Delta q^B > 0$ (convergence)	$\Delta H < 0$
Parameter assumptions in all regimes: $c_1^A = c_2^A$ and $c_1^B = c_2^B$			

Table 2. Asymmetries across providers

Regime	No integration	Integration	Health effect
$p < p_L$	$q_1^{AN} = q_2^{BN} > q_1^{BN} = q_2^{AN}$	$\Delta q_1^A = \Delta q_2^B > 0$ $\Delta q_1^B = \Delta q_2^A < 0$ (dispersion)	$\Delta H_{stayers} \gtrless 0$ $\Delta H_{switchers} \gtrless 0$
$p_L < p < p_H$	$q_1^{AN} = q_2^{BN} > q_1^{BN} = q_2^{AN}$	$\Delta q_1^A = \Delta q_2^B < 0$ $\Delta q_1^B = \Delta q_2^A < 0$	$\Delta H_{stayers} < 0$ $\Delta H_{switchers} < 0$
$p > p_H$	$q_1^{AN} = q_2^{BN} > q_1^{BN} = q_2^{AN}$	$\Delta q_1^A = \Delta q_2^B < 0$ $\Delta q_1^B = \Delta q_2^A > 0$ (convergence)	$\Delta H_{stayers} < 0$ $\Delta H_{switchers} < 0$
Assumptions: $c_1^A = c_2^B = c - \delta < c_1^B = c_2^A = c$			

Figure 1. Effect of integrated care under cost asymmetries across providers



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