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# Competition, quality and integrated health care☆

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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 countervailing effects of integration on quality of care. While integration makes coordination of care more profitable for providers due to bundled payments, it also softens competition as patient choice is restricted. We also identify circumstances due to asymmetries across providers and/or services under which integration either increases or reduces the quality of services provided. In the absence of synergies, 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. If the softening of competition effect is weak, integration is likely to improve quality and patient outcomes.

## 1. Introduction

Improving quality of care remains a primary motivation behind health system reforms. For decades several OECD countries have promoted competition among publicly funded hospitals to improve quality of care (EXPH, 2015; OECD, 2012). If patients have limited co-payments, providers have to compete on quality to attract patients and increase revenues. There is however 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. In most health systems the financing and provision of health care is distributed across a variety of distinct and often competing entities, each with its own objectives, obligations, and capabilities. These fragmented organisational structures may have adverse effects on the quality of care due to lack of coordination, misaligned incentives and poor information flows (Cebul et al., 2008; Elhauge, 2010).

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. Services from integrated providers are usually bundled together, and patients choose providers based on bundled services, whereas in a fragmented system

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patients choose services across different sets of providers. Thus, integration policies are likely to affect not only coordination of care, but can also reduce competition and increase market power.

In the US there have been several initiatives encouraging integrated care.[2] In England there has been a transition from competition to integration. The White Paper 'Integration and innovation: working together to improve health and social care for all' (2021) emphasises integrated delivery between primary care, community care, secondary care and mental health services.[3] It states that whilst competition can drive service improvement, it can also hinder integration between providers. Similar initiatives on integrated care have been introduced in other countries.[4]

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. 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. 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. Providers compete on quality, receive a fixed tariff per patient and set service quality independently. They differ in demand responsiveness to quality and provider costs of services. The model 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. 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. This has consequences for competition, as integrated providers can adjust service quality in response to different costs and demand elasticities in the two markets.

We identify three effects of integration on quality 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 *softening of competition effect* pulls towards weaker incentives for quality provision following integration and is due to restricted patient choice. 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 services. This *profit margin effect* pulls towards stronger incentives for quality provision following integration. Third, because demand might differ under integrated care, the marginal cost of providing quality might also differ.

To further characterise the effects of integration, we first assume that providers do not differ in the marginal cost of quality for a given service, but the services differ in demand responsiveness, marginal costs, regulated prices, and patient valuations of quality. In the absence of any synergies on benefits or costs, two consistent patterns emerge. First, integration leads to a quality increase for one type of service and a quality reduction for the other. Second, patients experience an increase in health benefits if integration leads to an increase in quality dispersion across services. The results are reversed if integration leads to a quality convergence across services.

We then explore some 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.

Finally, we extend the model to allow other aspects of coordination. First, we consider coordination gains from integration that arise from cost synergies or internalisation of cost complementarities across services. These could arise from integration policies that promote information sharing on patient needs, diagnosis, comorbidities, past treatments (more broadly health records), therefore reducing the cost of providing quality by avoiding duplication of services and providing more appropriate services. This extension highlights that the policy case for integration relies on the presence of synergies or complementarities across services. Second, we consider a scenario in which providers do not integrate but coordinate care by bundling their services, which highlights the role of financial integration across providers. If providers do not integrate but still receive a bundled payment for coordinated services, then revenues will be shared based on a rule which specifies the proportion of revenues allocated to each provider. We find that coordination without integration tends to reduce service quality because the *softening of competition effect* of restricted patient choice is preserved, while the *profit margin effect* is weakened. This extension highlights that coordination of services across providers combined with revenue sharing agreements weakens competition for patients.

[2] Health Maintenance Organizations (HMOs) integrated insurers with providers. Accountable Care Organizations (ACOs) integrated health care delivery under Patient Protection and Affordable Care Act. ACOs promote integrated care by allowing a network of hospitals and providers to jointly contract with the Center for Medicare and Medicaid Services.

[3] 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 (Collins, 2016). The evidence on the effect of these forms of integration remains limited (Baxter et al., 2018; Kumpunen et al., 2020; Lewis and Ling, 2020).

[4] 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.

The study is organised as follows. Section 2 reviews the literature. Section 3 presents the key assumptions. Section 4 derives the equilibrium quality when services are not integrated, and Section 5 when services are integrated. Section 6 compares equilibrium quality under the two scenarios. Section 7 is devoted to welfare analysis, whereas Section 8 extends the model with cost synergies and coordination of bundled services without integration. Section 9 discusses and concludes.

## 2. Related literature

Our paper relates to the literature on competitive effects of provider integration in health care markets.[5] 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, e.g., 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.[6] However, if prices are market based, hospital mergers tend to result in higher prices while the effects on quality are more ambiguous.[7]

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. While there exists a relatively large literature on vertical integration in general (see, e.g., Lafontaine and Slade, 2007), the number of studies in health care is much more sparse; see Gaynor et al. (2015). There are some 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 the physician practice is owned by that hospital.[8]

There is also a growing literature on Accountable Care Organizations (ACOs). 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, and 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 increases in prices and spending, and affect patients differently depending on their local hospital market conditions.

A recent strand of literature studies 'fragmentation' in health care delivery and the possible benefits from integration. Frandsen et al. (2019) 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. Agha et al. (2019), using US Medicare claims data, find that patients that move to a region with more fragmented delivery increase their use of specialists and have fewer encounters with primary care physicians. They also report that fragmented regions have more intensive care provision, including services sometimes associated with overutilisation and high value care.[9]

There are also studies of various 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.[10]

Outside the US, there are a few studies on integration. Fernandez et al. (2018) 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 coordination across local authorities can increase post-operative length of stay. Morciano et al. (2020) show that

5 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.

6 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.

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

8 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).

9 In a related paper, Agha et al. (2023) find that patients that move to regions where outpatient visits are concentrated within a small set of providers or switch to primary care physicians with higher organisational concentration of care delivery reduce their health care utilisation. They also report that more concentrated (less fragmented) care delivery predicts improvements in diabetes care and is not associated with greater use of emergency department or inpatient care.

10 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.

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 on integrated (as opposed to fragmented) care delivery along three dimensions. First, the vast majority of existing studies are almost exclusively empirical with very limited theoretical foundation. Our paper is, to our knowledge, a first attempt to offer a cohesive modelling framework for understanding the effects of integrated care on the quality of services offered to patients. Second, the existing literature is mostly focused on health care utilisation and cost savings as key outcomes of integrated care delivery with quality of care receiving much less attention. In contrast, our paper focuses on quality of care as the key outcome, and we show that integration imposes countervailing effects on providers' quality of care. This finding can explain the weak and often mixed results on quality indicators in the few studies that look at quality effects. Third, our paper focuses on a mostly neglected aspect of integrated care delivery by the existing literature, namely how integration changes the strategic interaction among care providers and thus competition in the health care market. While some may argue that competitive effects of non-horizontal integration are not necessarily of first-order importance, our study show that this might be a false conjecture.

The theoretical approach in our paper is also related to a strand of papers using spatial competition models to study vertical relationships in health care markets. For instance, Gal-Or (1997, 1999a) studies the interaction between health insurers and providers of health care (hospitals) when consumers have different (and independent) preferences for both types of suppliers. Gal-Or (1997) focuses on the incentives for selective contracting by insurers, whereas Gal-Or (1999a) studies horizontal mergers between either insurers or hospitals. While the set up in these papers resembles ours, none of these papers studies the effects of integrated care delivery. In a related paper Gal-Or (1999b) studies the incentives for vertical mergers between hospitals and primary care physicians. However, this paper is also quite different as it focuses on foreclosure effects rather than quality effects, and does not have an explicit focus on the effects of integrated (as opposed to fragmented) care delivery.

Finally, our paper is also somewhat related to the more general theoretical IO literature on mergers between firms that sell complementary products. If consumers demand a composite good that consists of components sold by competing firms, a basic insight from this literature is that a merger can lead to lower prices due to an internalisation of a negative externality (e.g., Economides and Salop, 1992; Choi, 2008). Such a negative externality is not present in the main part of our analysis, since we assume that each service is independently offered (and not offered as part of a composite service) in the non-integrated case. However, a similar type of externality appears in the extension to our main analysis, where we consider the cases of cost complementarities between providers and bundled services.

## 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 $B2$.[11] 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

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

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

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

where $D_i^k$ is the demand facing Provider $ki$, and where $c_i^k > 0$ is a provider- and service-specific cost parameter and $w$ is a fixed (volume-independent) quality cost parameter, capturing the (relative) importance of fixed versus variable cost in the care provision. Thus, we assume that the marginal cost of quality for a given service increases in output, implying that parts of the costs of quality

[11] 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.

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 specific contract $\left(T_k, p_k\right)$, 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 $k$.[12] 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[13]

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

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 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

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

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[14]

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

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

## 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

[12] 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.

[13] Demand for provider $k1$ and $k2$ are defined by $D_1^k = \int_0^{\hat{x}} ds$ and $D_2^k = \int_{\hat{x}}^1 ds$, respectively, where $\hat{x}$ is the location of the patient who is indifferent between the services from the two providers, i.e., $V\left(\hat{x}, k1\right) = V\left(\hat{x}, k2\right)$, as defined in (1). Solving this equality for $\hat{x}$ yields the demand function in (4).

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

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

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

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:

(1) 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. We refer to this as a *softening of competition effect*, since it follows from the fact that patient choice is restricted due to bundling of services under integration.

(2) 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. We refer to this as a *profit margin effect*, since it follows from the fact that payments are bundled under integration.

(3) 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. This effect relies on asymmetries across providers and/or services, which will be studied in detail below.

Since the first two effects go in opposite directions and the sign of the third effect 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 the *softening of competition effect* and the *profit margin effect* exactly cancel each other. Furthermore, equilibrium demand (in terms of number of patients) for Provider $ki$ under non-integration is equal to equilibrium demand for Provider $i$ under integration, implying that the third effect is zero. Consequently, under full symmetry, integrated care has no implications for equilibrium quality provision.

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. Table 1 below (in Section 6.1.5) summarises the key findings in terms of quality and health benefit that arise from asymmetries across services, while Table 2 (in Section 6.2.3) is devoted to asymmetries across providers.

### 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[15]

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

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 the third of the above explained effects vanishes. Thus, all potential impacts of integrated care on equilibrium quality provision go through the *softening of competition effect* and the *profit margin effect*.

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 care. The effect on health is therefore driven by the change in quality in each service weighted by the marginal valuation of quality of each service. In the first three scenarios discussed below (differences in costs, prices and demand elasticities), the marginal valuation of quality is the same across services and therefore the effect on health is only affected by changes in quality. This is not the case in the last scenario where differences across services arise precisely from differences in the marginal valuation of quality.

#### 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 provision. Then there exists a threshold level of the per-unit price, given by*

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

*such that:*

*(i) If $p < \hat{p}$, 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 $p > \hat{p}$, 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 the *profit margin effect*. 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.

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

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 $p > \hat{p}$, whereas the opposite holds if $p < \hat{p}$. Thus, patients health benefits increase if integration leads to quality dispersion and reduce if it leads to 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 the *profit margin effect* 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.

In the analysis so far we have assumed that price differences do not imply cost differences, and *vice versa*. In practice, one could argue that cost differences across services usually also imply price differences; i.e., if say $c^A > c^B$, then $p_A > p_B$. Allowing for two asymmetries (both prices and costs) would imply that the effects of integration are determined by a combination of the effects that are presented in Propositions 1 and 2. Whether the overall effects are closer to the first or the second Proposition depends on whether or not cost differences are larger than price differences. In Appendix B we provide an example where the price $p_k$ is proportional to the cost parameter $c^k$. We show that this implies that price differences dominate cost differences and that integration implies a quality convergence between the two services, as in Proposition 2.

#### 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 the *softening of competition effect*. 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 the former service 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 $b/2\left(t_A + t_B\right)$ 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 $b/2\left(t_A + t_B\right)$, whereas $b/2t_B$ is more that twice as large as $b/2\left(t_A + t_B\right)$, 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 $\left|b/t_k - 2b/\left(t_A + t_B\right)\right|$ 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*

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

*such that:*

*(i) If $\alpha < \hat{\alpha}$, 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 $\alpha > \hat{\alpha}$, 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 the *softening of competition effect* and the *profit margin effect* 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 $\alpha$ 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).

*6.1.5. Summary of findings with asymmetries across services*

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 have higher (lower) health benefit if integration leads to quality dispersion (convergence) across services.

**Table 1**
Asymmetries across services.

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

*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 $c_1^B = c_2^A = c$.

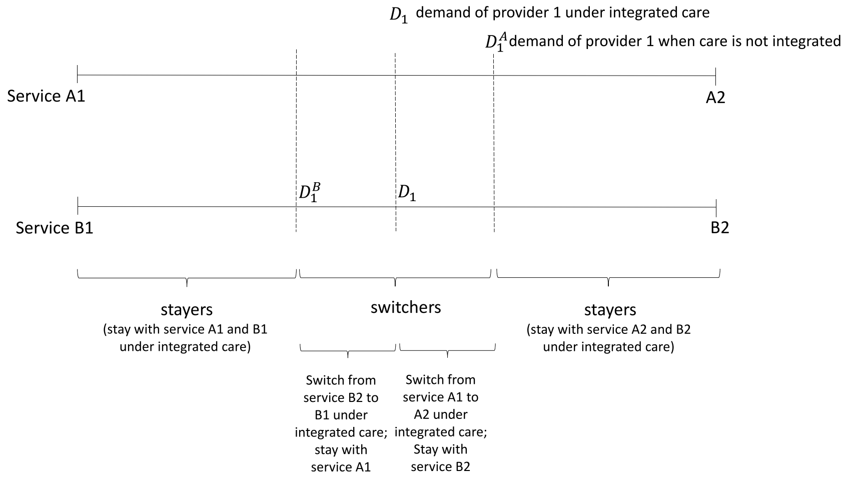


**Fig. 1.** Effect of integrated care under cost asymmetries across providers.

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 $B$.

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, an 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 Fig. 1.

### 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 the *profit margin effect*. 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 the third effect defined at the start of Section 6. 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 the aforementioned third effect. 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 Fig. 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.

### 6.2.3. Summary of findings with asymmetries across providers

The results presented in Propositions 5 and 6 are summarised in Table 2. It suggests that for intermediate prices qualities and health benefits reduce. For low prices, the quality of providers with a cost advantage increases and the quality of providers with a cost disadvantage reduces following integration, while the effect for both stayers and switchers is indeterminate. For high prices, the effects on qualities are reversed with integration reducing (increasing) quality for providers with a cost advantage (disadvantage), while the effect on the health of both stayers and switchers is negative. Therefore, the health effect is generally negative, except for low price, in which case it is ambiguous.

**Table 2**
Asymmetries across providers.

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

## 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.[16] 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

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

Instead, under integrated care, welfare is given by

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

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 6.2, 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

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

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 $A1$

[16] To avoid double counting of patient health benefit, we neglect providers' altruistic component. We also assume that third-party transfers (payments) to providers are welfare neutral and involve no distortions. Allowing for providers' altruistic component would imply that health benefits are inflated, and a higher first-best level of quality. Another reason for neglecting provider's altruistic component is that providers have a limited liability constraint and that the overall transfer to the provider has to cover the costs. In the presence of altruism, the participation constraint is always satisfied if the limited liability constraint is binding. See Chalkley and Malcomson (1998).

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 6 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, $\Delta^T$ 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 6.2, where $D_1 = 1/2$, this is true for both services. More generally, since aggregate mismatch costs are minimised 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 6.2, 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 $\Delta q^k$, 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).

**Table 3**
Welfare effects of integration with asymmetries across services.

| Regime | Effects of integration | | |
|---|---|---|---|
| | Qualities | Benefits and costs | Total welfare |
| $c^A < c^B$ & $p < \hat{p}$ | $\Delta q^A > 0; \Delta q^B < 0$ | $\Delta^H + \Delta^{VC} > 0; \Delta^{FC} > 0$ | $\Delta W \gtrless 0$ |
| $c^A < c^B$ & $p > \hat{p}$ | $\Delta q^A < 0; \Delta q^B > 0$ | $\Delta^H + \Delta^{VC} < 0; \Delta^{FC} < 0$ | $\Delta W \gtrless 0$ (>0 for high $p$) |
| $p^A > p^B$ | $\Delta q^A < 0; \Delta q^B > 0$ | $\Delta^H + \Delta^{VC} = 0; \Delta^{FC} < 0$ | $\Delta W > 0$ |
| $t^A < t^B$ | $\Delta q^A < 0; \Delta q^B > 0$ | $\Delta^H + \Delta^{VC} < 0; \Delta^{FC} < 0$ | $\Delta W \gtrless 0$ (>0 for high $p$) |
| $b^A > b^B$ & $\alpha < \hat{\alpha}$ | $\Delta q^A > 0; \Delta q^B < 0$ | $\Delta^H + \Delta^{VC} > 0; \Delta^{FC} > 0$ | $\Delta W \gtrless 0$ (<0 for high $p$) |
| $b^A > b^B$ & $\alpha > \hat{\alpha}$ | $\Delta q^A < 0; \Delta q^B > 0$ | $\Delta^H + \Delta^{VC} < 0; \Delta^{FC} < 0$ | $\Delta W \gtrless 0$ (>0 for high $p$) |
| In all regimes, $q^{AN} > q^{BN}$ in the equilibrium with non-integrated services. | | | |

A number of configurations are possible. Table 3 summarises the decomposed and total welfare effects of integration for the each of the cases analysed in Section 6.1, with asymmetry across services along one particular dimension.[17] The sign of the overall welfare effect of integration is unambiguously determined only for the case of treatment price differences. In this case we know from Proposition 2 that integration leads to quality convergence without affecting average quality, thus leaving patients' health benefits unchanged. When average quality is constant, variable costs are also unaffected. However, because of the convexity of the fixed-cost function, quality convergence implies a reduction the total fixed costs, with a corresponding increase in total welfare. In all the other cases considered, integration implies a welfare trade-off between health benefits (net of variable costs) and fixed costs of quality provision. If integration leads to higher health benefits, this comes at the expense of higher (fixed) costs of quality provision. And conversely, if integration leads to fixed-cost savings, this comes at the expense of lower health benefits. The overall welfare effect is therefore generally indeterminate. However, since health benefits increase linearly whereas fixed costs increase convexly in treatment prices, the effect of integration on fixed costs will outweigh the corresponding effect on health benefits for sufficiently high treatment prices.

## 8. Extensions

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. In this section we extend our main analysis in two different directions. First, we explore the possibility that integration can lead to cost synergies and also to an internalisation of cost complementarities, and we analyse how this might affect the quality of care. Cost synergies under integration reduce the marginal cost of providing each service. Cost complementarities are such that an increase in quality for one service reduces the marginal cost of providing quality for the other service. Second, we analyse an alternative way of organising service provision, namely through the use of bundled services. The providers coordinate their supply in the form of a service bundle while still choosing the service quality independently. In this setting, providers of different services receive a bundled payment, which they split based on a revenue sharing agreement, but they do not integrate.

### *8.1. Cost synergies and cost complementarities*

A main argument in favour of integration is that it leads to better coordination, for example through sharing of information between the integrated providers. This will potentially result in less duplication of services and unnecessary care, thus leading to cost reductions through a more efficient use of resources. Within our modelling framework, such synergies and coordination gains can be captured by extending the provider cost function in (2) such that the cost of providing Service $k$ for Provider $ki$ is now given by[18]

$$C_i^k\left(q_i^k, D_i^k, q_j^{-k}\right) = (1 - \Omega\mu)\, c q_i^k D_i^k + \frac{w}{2}\left(q_i^k\right)^2 - g q_i^k q_j^{-k}, \tag{36}$$

where $\Omega \in \{0,1\}$ is an indicator variable that takes the value 1 if the provider is integrated and 0 otherwise. This modified cost function allows for cost synergies and coordination gains to materialise in two different ways. First, integration directly reduces the variable cost of provision, where the parameter $\mu \in (0,1)$ measures the magnitude of this direct cost synergy. Second, the last term in (36) implies that there are cost complementarities between the two services. More specifically, a higher quality of one service will

[17] The effects summarised in Table 3 follow from the results presented in Propositions 1–4 and from the fact that the convexity of the fixed-cost function implies that quality convergence (dispersion) leads to a reduction (an increase) in total fixed costs if average quality does not increase (decrease).

[18] For simplicity, we focus on the fully symmetric case, where $b_A = b_B = b$, $t_A = t_B = t$, $p_A = p_B = p$ and $c_1^A = c_2^A = c_1^B = c_2^B = c$. However, our main results in this section do not rely on this symmetry assumption.

reduce the marginal cost of increasing the quality of the other service, and *vice versa*. The strength of these cost complementarities is given by the magnitude of the parameter $g > 0$.

With these modifications to our provider cost assumptions, the first-order condition for the optimal quality of Service $k$ chosen by Provider $ki$ under non-integration of services is given by

$$\frac{\partial \pi_i^k}{\partial q_i^k} = \left(p - (c - \alpha b)\, q_i^k\right) \frac{b}{2t} - (c - \alpha b)\, D_i^k - w q_i^k + g q_i^{-k} = 0, \tag{37}$$

which in the symmetric Nash equilibrium, where $q_i^k = q_j^{-k} = q^{N*}$ and $D_i^k = 1/2$, yields

$$q^{N*} = \frac{\frac{1}{2}\left(p\frac{b}{t} - (c - \alpha b)\right)}{(w - g) + \frac{(c-\alpha b)b}{2t}}. \tag{38}$$

In contrast, the first-order condition for the optimal quality choice of Service $k$ for the integrated Provider $i$ is given by

$$\frac{\partial \pi_i}{\partial q_i^k} = \left(p - (c\,(1-\mu) - \alpha b)\, q_i^k\right) \frac{b}{2t} - (c\,(1-\mu) - \alpha b)\, D_i - w q_i^k + g\left(q_i^k + q_i^{-k}\right) = 0, \tag{39}$$

which in the symmetric Nash equilibrium yields

$$q^{I*} = \frac{\frac{1}{2}\left(p\frac{b}{t} - (c\,(1-\mu) - \alpha b)\right)}{(w - 2g) + \frac{(c(1-\mu)-\alpha b)b}{2t}}. \tag{40}$$

A comparison of (38) and (40) shows that integration unambiguously leads to higher quality for both services, for two different reasons. First, the assumption of a direct cost synergy implies that each patient becomes more profitable, all else equal, which gives each integrated entity an incentive to increase the quality of its services in order to attract more demand. Second, the assumption of cost complementarities means that a cost externality is internalised through provider integration, in the sense that the integrated entity takes into account that higher quality of one service reduces the marginal cost of increasing the quality of the other (as we can see from the last term in (39)). This leads to higher quality for both services when they are offered by the same (integrated) provider. This quality increase might nevertheless imply that the overall cost of provision goes up as a result of integration.[19]

### 8.2. *Bundled services: coordination without integration*

As an alternative to provider integration, consider the case of bundled services, where quality choices are made by independent providers that coordinate their services (i.e., offer a service bundle) and either share the revenues or collect them individually. Suppose that Provider $A1$ and Provider $B1$ bundle their services, and that Provider $A2$ and Provider $B2$ do the same. For illustrative purposes, we now let the payment potentially differ between the two services while keeping the rest of the model symmetric.[20]

In the benchmark case of no integration and no service bundling, the payoffs of Provider $Ai$ are given by

$$\pi_i^A = T_A + \left(p_A + \alpha b q_i^A - c q_i^A\right) D_i^A - \frac{w}{2}\left(q_i^A\right)^2, \tag{41}$$

where

$$D_i^A = \frac{1}{2} + \frac{b\left(q_i^A - q_j^A\right)}{2t}. \tag{42}$$

On the other hand, if Provider $Ai$ and Provider $Bi$ bundle their services but do not share the revenues (i.e., the providers collect the service payment individually), the payoffs of Provider $Ai$ are given by

$$\hat{\pi}_i^A = T_A + \left(p_A + \alpha b q_i^A - c q_i^A\right) D_i - \frac{w}{2}\left(q_i^A\right)^2, \tag{43}$$

where

$$D_i = \frac{1}{2} + \frac{b\left(q_i^A - q_j^A + q_i^B - q_j^B\right)}{4t}. \tag{44}$$

Notice that demand for each provider is identical under full integration and under service bundling.

Finally, if service bundling also implies a bundled payment which is split based on a revenue sharing rule, the payoffs of Provider $Ai$ are given by

$$\tilde{\pi}_i^A = \theta\left(T_A + T_B\right) + \left(\theta\left(p_A + p_B\right) + \alpha b q_i^A - c q_i^A\right) D_i - \frac{w}{2}\left(q_i^A\right)^2, \tag{45}$$

[19] Numerical simulations suggest that the cost increase related to higher quality provision tends to outweigh the cost reductions stemming from cost synergies and cost complementarities.

[20] Keep in mind that our main results in this section do not rely on the symmetry assumption.

where $\theta \in (0, 1)$ is the share of the bundled payment that accrue to Provider $Ai$. We can think of this institutional setting as a form of coordination combined with financial integration for reimbursement purposes. Once the revenues are collected through the bundled payment, they are then split internally under a general revenue sharing agreement captured by the parameter $\theta$. Note that if this parameter is proportional to the price, $\theta = p_A/(p_A + p_B)$, we can recover the previous scenario where providers collect the service payment individually.

The incentives for quality provision under each of these three scenarios are found by deriving the respective first-order conditions, which are given by

$$\frac{\partial \pi_i^A}{\partial q_i^A} = \left(p_A - cq_i^A\right) \frac{\partial D_i^A}{\partial q_i^A} + cD_i^A - wq_i^A = 0, \tag{46}$$

$$\frac{\partial \widehat{\pi}_i^A}{\partial q_i^A} = \left(p_A - cq_i^A\right) \frac{\partial D_i}{\partial q_i^A} + cD_i - wq_i^A = 0, \tag{47}$$

$$\frac{\partial \widetilde{\pi}_i^A}{\partial q_i^A} = \left(\theta\left(p_A + p_B\right) - cq_i^A\right) \frac{\partial D_i}{\partial q_i^A} - cD_i - wq_i^A = 0, \tag{48}$$

where $\partial D_i^A/\partial q_i^A = b/2t$ and $\partial D_i/\partial q_i^A = b/4t$.

The main effect of service bundling is that it makes demand less responsive to quality ($\partial D_i/\partial q_i^A < \partial D_i^A/\partial q_i^A$). This is what we have previously referred to as the *softening of competition effect* of integration. If the payments are collected individually by each provider, this is the only effect of service bundling. We can therefore unambiguously conclude that this leads to lower quality provision than in the benchmark case of no service bundling. This can be directly seen from a comparison of (46) and (47) when evaluated in equilibrium (where $D_i^A = D_i = 1/2$). If the two providers that bundle their services also share the revenues, the same conclusion holds as long as the sharing rule is not too uneven. However, it is easily confirmed that if $\theta$ is so large that the quality of Service $A$ increases with bundled payment and revenue sharing, then the quality of Service $B$ drops, and *vice versa*. And in any case, the average quality of the two services always goes down as a result of bundling. We summarise the effects of service bundling as follows:

**Proposition 7.** *Compared to a benchmark in which providers offer services independently, service bundling leads to (i) lower quality of both services if the revenues are shared in a way that is not too unequal, and (ii) lower average service quality regardless of how the revenues are shared.*

Our analysis clearly suggests that service bundling has an overall negative effect on the quality of the services, and that the providers have stronger incentives for quality provision if they operate either fully independently or fully integrated. The reason is that service bundling introduces a form of coordination across services that only reduces demand-responsiveness to quality (the *softening of competition effect* of full integration) without allowing the providers to internalise the full value of each patient that can only be achieved by integration (the *profit margin effect* of full integration). In terms of incentives for quality provision, service bundling is therefore an organisational scheme that imposes the costs of full integration without the associated benefits, thus leading to lower service quality.

## 9. Discussion and concluding remarks

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 is generally ambiguous and determined by two counteracting forces. First, under integrated care, demand responds less to quality because the quality of a single service is of relatively less importance when patients choose between 'packages' containing more than one service. This effect pulls in the direction of *weaker* incentives for quality provision as a result of integration. Second, since patients demand two services from the same provider under integrated care, each extra patient is more valuable to the provider. This effect pulls in the direction of *stronger* incentives for quality provision.[21]

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 increases quality for one type of service and reduces it 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, but both convergence or dispersion can arise in the presence of differences in costs and valuations of quality across services (see Table 1). Perhaps counterintuitively, we show that patients tend to experience a health loss if integration leads to quality convergence across services, as the health loss from the reduction in quality in one service outweighs the health gain 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 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

[21] In addition, since providers are 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.

that when integration leads to quality convergence the health benefits are reduced for both stayers and switchers, while the effect on health benefits is indeterminate when integration leads to quality dispersion (see Table 2). The presence of cost synergies or cost complementarities makes integration more favourable as it increases incentives for quality and improves patients' health benefits. Integration internalises cost complementarities across services, giving stronger incentives to improve quality.

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 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. Our analysis has identified several characteristics, in terms of costs, demand and benefits, that are likely to generate improvements in quality or health benefits. Two favourable characteristics towards integration are either cost synergies or cost complementarities. These are conceptually distinct. For example, sharing of data and information can reduce the cost of providing quality of any service through more informed choices. In other scenarios, cost complementarities may generate additional benefits: higher quality in primary care, through appropriate medication and treatment while waiting for secondary care, can reduce the cost of specialist care if the health of the patient deteriorates slowly. Another scenario that is favourable to integration is when (i) quality differs markedly across services, and (ii) financial or non-financial incentives are rather weak (e.g., due to low reimbursed tariffs or low intrinsic motivation). We show that integration leads to improved health outcomes in these scenarios (see Table 1) despite the increase in quality dispersion across services.

In contrast, one characteristic that is not favourable to integration is the presence of high dispersion of quality across providers within services, with some providing high quality and others providing low quality. This is because patients are likely to value more the ability to select a provider of their choice across services, rather than finding themselves locked with a provider for a service that would not have been chosen without a bundle. Similarly, if quality differs markedly across services, and if financial or non-financial incentives are strong, then integration is more likely to lead to quality reductions that ultimately generate worse health outcomes. Finally, we show that an institutional setting which allows providers to coordinate services without fully integrating leads to worse quality and health outcomes than both a non-integrated (competitive) model and a fully integrated one.

Our study has some limitations. First, we have disregarded mixed schemes with both integrated providers and non-integrated providers. Second, integrated care could be modelled as involving a 'monopolisation' of the care provision, eliminating patient choice and competition completely. Third, we assume a duopoly in each market. Fourth, we assume providers have fixed locations on the Hotelling line, where the locations can be interpreted in product space or as geographical distance. Fifth, our analysis is made in an institutional context where providers face regulated prices and compete only on quality. Future research could explore the role of mixed schemes, monopolisation of provision, more than two providers, endogenous location (e.g., Brekke et al., 2006) and endogenous price (Brekke et al., 2020).

## CRediT authorship contribution statement

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## Appendix A. Proofs

**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

$$\Delta q^k = \frac{b\left(c^k - c^{-k}\right) Y}{2w\left(2wt + b\left(c^k - \alpha b\right)\right)\left(4wt + b\left(c^k + c^{-k} - 2\alpha b\right)\right)}, \tag{A.1}$$

where

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

Using (A.1) and (14), the effect of integrated care on patients' health benefit is given by

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

From (A.2) it follows that

$$Y > (<) 0 \text{ if } p > (<) \hat{p} := \frac{2w\left(t\left(c^k + c^{-k}\right) - 2\alpha bt\right) + b\left(c^k - \alpha b\right)\left(c^{-k} - \alpha b\right)}{2bw}. \tag{A.4}$$

Notice that $\hat{p}$ is higher than the price level needed to ensure an interior solution; i.e., $q^k > 0$ with and without integration for $p = \hat{p}$. Given (A4), the results in the proposition then follows directly from an inspection of (A.1) and (A.3). □

**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

$$\Delta q^k = \frac{b\left(p_{-k} - p_k\right)}{2\left(2wt + b\left(c - \alpha b\right)\right)} < (>)\, 0 \text{ if } p_k > (<)\, p_{-k}. \tag{A.5}$$

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

**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

$$\Delta q^k = \frac{b\left(t_k - t_{-k}\right)\left[2pw + (c - \alpha b)^2\right]}{2\left(2kw + b\left(c - \alpha b\right)\right)\left(w\left(t_k + t_{-k}\right) + b\left(c - \alpha b\right)\right)} > (<)\, 0 \text{ if } t_k > (<)\, t_{-k}. \tag{A.6}$$

Using (A.6) and (14), the effect of integrated care on patients' health benefit is given by

$$\Delta H = -\frac{wb^2\left(2pw + (c - \alpha b)^2\right)\left(t_k - t_{-k}\right)^2}{\left(2wt_k + b\left(c - \alpha b\right)\right)\left(2wt_{-k} + b\left(c - \alpha b\right)\right)\left(k\left(t_k + t_{-k}\right) + b\left(c - b\alpha\right)\right)} < 0. \quad \square \tag{A.7}$$

**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

$$\Delta q^k = \frac{b\left(b_k - b_{-k}\right)\Theta}{2w\left(2wt + b_k\left(c - \alpha b_k\right)\right)\left(4wt + \sum_{s=A,B} b_s\left(c - \alpha b_s\right)\right)}, \tag{A.8}$$

where

$$\Theta := \left(2w\left((p + \alpha t)\left(c - \alpha\left(b_k + b_{-k}\right)\right) + \alpha c t\right) + c\left(c - \alpha b_k\right)\left(c - \alpha b_{-k}\right)\right). \tag{A.9}$$

Using (A.8) and (14), the effect of integrated care on patients' health benefit is given by

$$\Delta H = \frac{\left(b_k - b_{-k}\right)^2\left[2wt\left(b_k + b_{-k}\right) + b_k b_{-k} c\right]\Theta}{2w\left(2wt + b_{-k}\left(c - \alpha b_{-k}\right)\right)\left(2wt + b_k\left(c - \alpha b_k\right)\right)\left(4wt + \sum_{s=A,B} b_s\left(c - \alpha b_s\right)\right)}. \tag{A.10}$$

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 $\Theta$ *a priori* indeterminate. From (A.9) we derive

$$\frac{\partial\Theta}{\partial\alpha} = -\left(w\left(2p + 4\alpha t\right) + c^2\right)\left(b_k + b_{-k}\right) + 2c\left(2wt + \alpha b_k b_{-k}\right), \tag{A.11}$$

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, $\Theta$ is potentially negative if $\alpha$ is sufficiently high. Suppose that $b_k > b_{-k}$, which implies that the upper bound on $\alpha$ is $c/b_{-k}$. Setting $\alpha = c/b_{-k}$ in (A.9) 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 $\alpha > (<)\, \hat{\alpha}$, where $\hat{\alpha} \in \left(c/\left(b_k + b_{-k}\right), \min\left\{c/b_k, c/b_{-k}\right\}\right)$. The results in the proposition then follows directly from (A.8) and (A.10). □

**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

$$\Delta q_1^A = \Delta q_2^B = -\frac{\delta b\left[(2wt + b(c - \alpha b))(2pwb - (c - \alpha b)(8wt + 3b(c - \alpha b))) + \delta\theta_1\right]}{2w\left(4wt + 2b(c - \alpha b) - \delta b\right)\Psi}, \tag{A.12}$$

$$\Delta q_1^B = \Delta q_2^A = \frac{\delta b\left[(2wt + b(c - \alpha b))(2pwb - (c - \alpha b)(8wt + 3b(c - \alpha b))) + \delta\theta_2\right]}{2w\left(4wt + 2b(c - \alpha b) - \delta b\right)\Psi} \tag{A.13}$$

where

$$\theta_1 := 3b^2(c - \alpha b)^2 + k\left(2pb^2 + 2t\left(6wt + 5b(c - \alpha b)\right)\right), \tag{A.14}$$

$$\theta_2 := 3b(c - \alpha b)\left(2\left(3wt + b(c - \alpha b)\right) - \delta b\right) + 4w\left(t\left(wt - \delta b\right) - pb^2\right) \tag{A.15}$$

and

$$\Psi := (2wt + 3b(c - \alpha b))(2wt + b(c - \alpha b)) - \delta b\left(4wt + 3b(c - \alpha b)\right) > 0. \tag{A.16}$$

The signs of (A.12) and (A.13) depend on the signs of the respective numerators. Let the expressions in the square brackets of the numerators in (A.12) and (A.13) be denoted by $N_1$ and $N_2$, respectively. These expressions depend on $p$ as follows:

$$\frac{\partial N_1}{\partial p} = 2bw\left(2wt + b(c - \alpha b) + \delta b\right) > 0, \tag{A.17}$$

$$\frac{\partial N_2}{\partial p} = 2bw\left(2wt + b(c - \alpha b) - 2\delta b\right) > 0. \tag{A.18}$$

The positive sign of (A.18) 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,

$$p_1 = \frac{\begin{bmatrix} (c-\alpha b)(8wt+3b(c-\alpha b))(2wt+b(c-\alpha b)) \\ -\delta\left(3b^2(c-\alpha b)^2+2wt(6wt+5b(c-\alpha b))\right) \end{bmatrix}}{2bw(2wt+b(c-\alpha b)+\delta b)} \tag{A.19}$$

and

$$p_2 = \frac{\begin{bmatrix} (c-\alpha b)(8wt+3b(c-\alpha b))(2wt+b(c-\alpha b)) \\ -\delta(3b(c-\alpha b)(6wt+2b(c-\alpha b)-\delta b)+4wt(kt-\delta b)) \end{bmatrix}}{2bw(2wt+b(c-\alpha b)-2\delta b)}. \tag{A.20}$$

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

$$p_2 - p_1 = \delta\frac{\left(4wt(wt+2b(c-\alpha b)-\delta b)+3b^2(c-\alpha b)(c-\delta-\alpha b)\right)(4wt+2b(c-\alpha b)-\delta b)}{2bw(2wt+b(c-\alpha b)-2\delta b)(2wt+b(c-\alpha b)+\delta b)}. \tag{A.21}$$

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

$$\frac{\partial N_p}{\partial \delta} = -b\left[(2wt+b(c-\alpha b))(10wt+9b(c-\alpha b))-2\delta b(4wt+3b(c-\alpha b))\right]. \tag{A.22}$$

This expression is clearly negative for a sufficiently low value of $\delta$, and the scope for a negative sign is smaller the higher $\delta$. Setting $\delta$ at the upper bound $\delta = \overline{\delta}$, the expression in (A.22) 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 (A.21) is monotonically decreasing in $\delta$. Setting $\delta = \overline{\delta}$ in (A.21), it is easy to verify that the numerator in (A.21) 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 (A.19) and (23), we have

$$p_1 - \overline{p} = \frac{(c-\delta-\alpha b)(6wt+3b(c-\alpha b)+\delta b)(4wt+2b(c-\alpha b)-\delta b)}{4bw(2wt+b(c-\alpha b)+\delta b)} > 0. \tag{A.23}$$

By relabelling $p_1$ and $p_2$ as $p_L$ and $p_H$, respectively, the results in Proposition 5 follow. □

**Proof of Proposition 6.** Using (A.12)–(A.13) and (25), the effect of integrated care on the health benefit of *stayers* is given by

$$\Delta H_{stayers} = -\frac{\delta^2 b^2\left[6pwb^2+8w^2t^2-b(c-\alpha b)(8wt+3b(c-\alpha b))+\delta b(4wt+3b(c-\alpha b))\right]}{2w(4wt+2b(c-\alpha b)-\delta b)\Phi}, \tag{A.24}$$

where

$$\Phi := (2wt+b(c-\alpha b))(2wt+3b(c-\alpha b))-\delta b(4wt+3b(c-\alpha b)) > 0. \tag{A.25}$$

The sign of (A.24) 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

$$p_3 = -\frac{\left(8w^2t^2-b(c-\alpha b)(8wt+3b(c-b\alpha))+\delta b(4wt+3b(c-\alpha b))\right)}{6wb^2}. \tag{A.26}$$

A comparison of $p_3$ and $p_L$ $(= p_1)$, given by (A.19), yields

$$p_L - p_3 = \frac{(4wt+b(2(c-\alpha b)-\delta))\begin{pmatrix}(2wt+3b(c-\alpha b))(2wt+b(c-\alpha b)) \\ -\delta b(4wt+3b(c-\alpha b))\end{pmatrix}}{6wb^2(2wt+b(c-\alpha b+\delta))}. \tag{A.27}$$

The sign of this expression depends on the sign of the second factor in the numerator, which is monotonically decreasing in $\delta$. 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

$$\overline{p} - p_3 = \frac{[4kt+b(2(c-\alpha b)-\Delta)][4kt-3b(c-\Delta-\alpha b)]}{12kb^2}. \tag{A.28}$$

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

$$\alpha > \alpha_1 := \frac{c-\delta}{b} - \frac{4wt}{3b^2}. \tag{A.29}$$

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

Using (A.12)–(A.13) and (26), the effect of integrated care on the health benefit of *switchers* is given by

$$\Delta H_{switchers} = -\frac{\delta b}{2}\frac{\left[\begin{array}{c} 4w\left(2wt + b\left(c-\alpha b\right)\right)\left(pb^2 + 2wt^2\right) \\ +\delta b\left(\begin{array}{c} 4w\left(pb^2 + wt^2\right) + \delta b\left(4wt + 3b\left(c-\alpha b\right)\right) \\ -b\left(c-\alpha b\right)\left(8wt + 3b\left(c-\alpha b\right)\right)\end{array}\right)\end{array}\right]}{w\left(4wt + 2b\left(c-\alpha b\right) - \delta b\right)\Phi}. \tag{A.30}$$

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

$$p_4 = -\frac{\left[\begin{array}{c} 8w^2t^2\left(b\left(c-\alpha b\right) + 2wt\right) \\ +\delta b\left(4w^2t^2 - b\left(c-\alpha b\right)\left(3b\left(c-\alpha b\right) + 8wt\right) + \delta b\left(3b\left(c-\alpha b\right) + 4wt\right)\right)\end{array}\right]}{4wb^2\left(\delta b + \left(b\left(c-\alpha b\right) + 2wt\right)\right)}. \tag{A.31}$$

A comparison of $p_4$ and $p_L$ yields

$$p_L - p_4 = \frac{\left[\begin{array}{c}\left(2wt + 3b\left(c-\alpha b\right)\right)\left(2wt + b\left(c-\alpha b\right)\right) \\ -\delta b\left(4wt + 3b\left(c-\alpha b\right)\right)\end{array}\right]\left[4wt + b\left(2\left(c-\alpha b\right) - \delta\right)\right]}{4wb^2\left(2wt + b\left(c + \delta - \alpha b\right)\right)}. \tag{A.32}$$

The sign of this expression depends on the sign of the first factor in the numerator, which is monotonically decreasing in $\delta$. 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

$$\overline{p} - p_4 = \left[2wt\left(2wt + b\left(c-\alpha b\right)\right) + \delta b\left(2wt - b\left(c - \delta - \alpha b\right)\right)\right]\frac{4wt + b\left(2\left(c-\alpha b\right) - \delta\right)}{4wb^2\left(2wt + b\left(c - \alpha b + \delta\right)\right)}. \tag{A.33}$$

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

$$\alpha > \alpha_2 := \frac{c-\delta}{b} - \frac{2tw}{b^2}. \tag{A.34}$$

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*. $\square$

**Proof of Proposition 7.** The Nash equilibrium in each of the three cases is derived from the first-order conditions in (46)–(48). In the benchmark case of no service bundling, equilibrium qualities are given by

$$q_i^A = \frac{bp_A - \left(c-\alpha b\right)t}{2wt + \left(c-\alpha b\right)b} \quad \text{and} \quad q_i^B = \frac{bp_B - \left(c-\alpha b\right)t}{2wt + \left(c-\alpha b\right)b}, \tag{A.35}$$

and under service bundling with revenue sharing, equilibrium qualities are

$$\widetilde{q}_i^A = \frac{\theta\left(p_A + p_B\right)b - 2\left(c-\alpha b\right)t}{4wt + \left(c-\alpha b\right)b} \quad \text{and} \quad \widetilde{q}_i^B = \frac{\left(1-\theta\right)\left(p_A + p_B\right)b - 2\left(c-\alpha b\right)t}{4wt + \left(c-\alpha b\right)b}. \tag{A.36}$$

Notice that service bundling without revenue sharing is a special case of (A.36) with $\theta = p_A/\left(p_A + p_B\right)$. Furthermore, the average quality in the benchmark case is given by

$$q_i^{av} = \frac{1}{2}\left(q_i^A + q_i^B\right) = \frac{b\left(p_A + p_B\right) - 2\left(c-\alpha b\right)t}{2\left(2wt + \left(c-\alpha b\right)b\right)}, \tag{A.37}$$

whereas average quality when the services are bundled is given by

$$\widetilde{q}_i^{av} = \frac{1}{2}\left(\widetilde{q}_i^A + \widetilde{q}_i^B\right) = \frac{b\left(p_A + p_B\right) - 4\left(c-\alpha b\right)t}{2\left(4wt + \left(c-\alpha b\right)b\right)}. \tag{A.38}$$

Comparing (A.35) and (A.36), it is easily verified that

$$q_i^A > \widetilde{q}_i^A \text{ if } \theta < \theta_A := \frac{\left(c-\alpha b\right)\left(bp_A + t\left(c-\alpha b\right)\right) + 4twp_A}{\left(p_A + p_B\right)\left(2tw + \left(c-\alpha b\right)b\right)} \tag{A.39}$$

and

$$q_i^B > \widetilde{q}_i^B \text{ if } \theta > \theta_B := \frac{\left(c-\alpha b\right)\left(bp_A - t\left(c-\alpha b\right)\right) + 2tw\left(p_A - p_B\right)}{\left(p_A + p_B\right)\left(2tw + \left(c-\alpha b\right)b\right)}, \tag{A.40}$$

where

$$\theta_A - \theta_B = \frac{\left(\left(p_A + p_B\right)w + \left(c-\alpha b\right)^2\right)2t}{\left(p_A + p_B\right)\left(2tw + \left(c-\alpha b\right)b\right)} > 0, \tag{A.41}$$

which implies that $q_i^A > \widetilde{q}_i^A$ and $q_i^B > \widetilde{q}_i^B$ if $\theta \in \left(\theta_B, \theta_A\right)$. Comparing (37) and (38), a simple visual inspection reveals that the numerator is larger and the denominator is smaller in (37) than in (38), thus implying that $q_i^{av} > \widetilde{q}_i^{av}$ for all $\theta \in (0,1)$. $\square$

## Appendix B. Price and cost differences across the two services

Suppose that the unit price of Service $k$ is proportional to the cost of providing the service. More specifically, suppose that $p_k = \gamma c^k$, where $\gamma$ is a positive parameter. We assume that the two services are symmetric in all other respects, and also that the two providers of each service are symmetric. Additionally, we assume for simplicity that the providers are profit-maximisers; i.e., $\alpha = 0$.

With the above stated assumptions, it is straightforward to derive the Nash equilibrium quality of Service $k$ in the non-integration case, given by

$$q^{kN} = \frac{(\gamma b - t)\, c^k}{2wt + bc^k}. \tag{B.1}$$

An interior solution (with quality choices above the minimum level) requires that $\gamma > t/b$. If this condition holds, it is easily verified that $q^{kN}$ is monotonically increasing in $c^k$, which means that equilibrium quality is higher for the service that is more costly to provide. The reason for this is that the price increase more than compensates for the cost increase. In other words, price differences dominate cost differences.

Under provider integration, the equilibrium quality of Service $k$ is given by

$$q^{kI} = \frac{2w\left(\gamma b\left(c^k + c^{-k}\right) - 2tc^k\right) + b\left(c^{-k} - c^k\right)c^{-k}}{2k\left(4kt + b\left(c^k + c^{-k}\right)\right)}. \tag{B.2}$$

A comparison of (B.1) and (B.2) yields

$$q^{kI} - q^{kN} = -b\left(c^k - c^{-k}\right)\frac{2wt\left(c^k + c^{-k} + 2w\gamma\right) + bc^k c^{-k}}{2w\left(2wt + bc^k\right)\left(4wt + b\left(c^k + c^{-k}\right)\right)} > (<)\, 0 \;\text{ if }\; c^k < (>)\, c^{-k}. \tag{B.3}$$

Thus, integration leads to a quality increase for the service with lower provision cost and a quality decrease for the other service. Since quality is initially higher for the most costly service, this implies a quality convergence between the two services, similarly to Proposition 2.

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