Comparative Efficiency Analysis of Referral Costs in GP units

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Abstract
The aim of this paper is to compare English General Practitioner (GP) units in terms of their overall referral costs through Data Envelopment Analysis (DEA). Results revealed potential cost savings and benchmark practices under 4 perspectives: 'overall cost efficiency', 'technical efficiency', 'allocative efficiency', and 'price efficiency'.

Keywords: Efficiency, Data Envelopment Analysis, Health

Introduction
General Practitioner (GP) units are the gateway to health services delivered to individuals in England. Except for emergencies, GPs make the clinical decisions to refer or otherwise an individual and if so whether as inpatient or outpatient. In addition GPs exert considerable influence as to the provider of the services that the referred patient is to receive. These GP decisions lead to inpatient and outpatient referral costs incurred by the NHS. It is these referral costs that are the subject of this paper.

Using a method known as Data Envelopment Analysis (**DEA**) the referral costs incurred by each GP practice are set against the size, mix by age, gender and multiple deprivation of the list population registered with each practice. This leads to the identification of benchmark GP units which incur minimum referral costs relative to size and mix of population covered. These practices are seen as potential repositories of cost-efficient operating practices, subject to clinical quality of services not being compromised. For GP units that are not identified as benchmark the analysis ascertains the following information:

- The scope for savings on referral costs through simply reducing but not altering the mix between inpatient and outpatient referrals;
- The scope for additional savings in referral costs through switching between inpatient and outpatient referrals;

- The scope for a third component of savings on referral costs through securing lower inpatient and/or outpatient prices. This component could reflect a judicious choice of providers by benchmark GP units.

For each non benchmark practice a small number of benchmark GP units are identified at which the former can look at in order to identify operating practices that may enable it to realise the estimated savings in referral costs. The benchmark practices corresponding to each non benchmark practice on each component of potential savings are identified so as to be as close as possible in terms of list size and mix of patients covered by age, gender and deprivation.

State of the Art

The total costs incurred by a GP can be divided into two types: the **cost of providing the health service** (related to doctors and nurse time, drugs and materials costs), and the **cost of purchasing hospital care for their patients** (cost of referrals). This distinction has been put forward by Puig-Junoy and Ortún (2003) in an analysis of primary health care services in Catalonia, Spain. Most studies on GP units in the literature have looked at the efficiency of providing the health service, i.e. the efficiency of translating resources available (staff, materials and technology) into health intermediate outputs (such as consultations and treatments of various types). Examples of such studies include Szczepura et al. (1993), Thanassoulis et al. (1995), Zavras et al. (2002), Rosenman and Friesner (2004), and Amado and Santos (2009). According to Chilingerian and Sherman (2004), the perspective of looking at a practice as an entity transforming medical and other resources into intermediate outputs is a managerial perspective. Another possibility is the clinical perspective, where efficiency requires that medical decision-making utilizes the minimal quantity of clinical resources (such as consultations, referrals, treatments, and drugs) to achieve a constant quality outcome, when caring for patients with similar diagnosis complexity and severity. Note that the intermediate outputs in the managerial perspective are taken as inputs in the clinical perspective (see for details, Chilingerian and Sherman , 2004).

In our analysis we follow more closely the clinical perspective of GP units, but the intermediate outputs we focus on are only the referrals to hospital care. Therefore, our aim is to understand how practices compare between themselves in the costs and volumes of 'purchasing' hospital care. We will therefore analyse both cost and volumes of referrals within GPs.

Other studies, such as Luoma et al (1996), Salinas-Jimenez and Smith (1996), Puig-Junoy and Ortún (2003), and Sorensen et al. (2009), have focused on costs for the assessment of GPs. Sorensen et al. (2009) analysed GPs in Denmark where the health care system appears to be similar to the one in the UK, since "GPs play a key role in allocating the use of resources available in the health care system" (p.1). The authors were mainly interested in analysing the following expenditures associated with GP units: treating patients in their own practice; referring patients to other health care providers; and prescribing pharmaceuticals. The adopted methodology was multilevel analysis. The total costs modelled were expenditures with fee-for–service activity, pharmaceuticals, referrals to practicing specialists, referrals to outpatient care and referrals to inpatient care. The total cost was analysed in relation to variables that reflected the list composition of the GP (e.g., number of enrolled persons aged 0 to 19, number of enrolled persons aged over 65, males with a higher education (disaggregated in categories of employment – self employed, employed, unemployed, on transfer income), females with a higher education (disaggregated in categories of employment – self employed, employed, unemployed, on transfer income), males with no higher education (disaggregated in categories of employment – self employed, employed, unemployed, on transfer income), and females with no higher education (disaggregated in categories of employment – self employed, employed, unemployed, on transfer income)). The inclusion of these variables to characterise the list population relate to the fact that some Danish studies show that the number of inpatient visits increases with age, and unemployment and decreases with the degree of education. The variables were therefore related with age, gender, education and work status. Our analysis is similar to that carried out by Sorensen et al. (2009), since our aim too is to analyse the referral costs incurred by GP units, given the size and the mix of the population covered by the practice.

Data set

We use Data Envelopment Analysis (DEA) to compare 75 GP units in the UK on costs of referrals. In this framework referral costs will be the input to the model while the outputs will be variables that reflect the size and mix of population covered through these referral costs. Table 1 reflects the inputs and outputs used in the DEA model reported in this paper.

Table 1: Alternative Models for Assessing GP units on Costs of Referrals

Inputs	Outputs
Cost of referrals for inpatient care Cost of referrals for outpatient care	List of population enrolled in the practice, divided into homogeneous groups

The outputs used are not ‘real’ outputs in the production economics sense. We use list population on the output side as a control variable for comparing the referrals costs on the input side. There is some discussion in the literature regarding the use of total population registered versus the use of the patients that actually visited the practice. For example, Amado and Dyson (2008) suggest that the use of registered population has some problems since it assumes that all the patients registered are receiving the necessary services, and that the services provided are appropriate and of similar quality. Therefore they suggest that, since having a patient on the list does not mean service delivery, the use of visits/consultations would be better than the list population. In our case, however, we favour the use of list population rather than the use of consultations on the output side of the assessment. The reason for this choice is that a higher number of visits can in fact be an indicator of inefficiency all else being equal. If a GP practice does not treat patients with adequate clinical quality, they tend to visit the practice more often than when the service is better. Therefore, we prefer to use on the output side a variable that the practice cannot control (list population) rather than a variable that could be easily manipulated to show the practice in a better light (number of visits).

Note however, that the argument of Amado and Dyson (2008) regarding the assumption of equal quality of care is also being invoked in our case. This is because we allow for size and mix of population when comparing practices on referral costs but do not allow for the quality of clinical care received by those patients. Therefore we implicitly assume that all GPs deliver care of similar quality in the sense that their clinical judgment takes priority over economic considerations in deciding how to refer a patient. This assumption was also made by Sorensen et al. (2009).

Research and clinical judgment shows that the health needs of an individual, among other things, are dependent on age and gender. Hence, in order to reflect the health needs of the population covered by a GP, we subdivide its list population into age/gender groups. Note that this is not implying that all those in a given age/gender group will have the same health needs. Rather a similar proportion of those in a given group would have a given health need all else (e.g. deprivation level) being equal. In order to construct homogeneous groups by age and gender we used 8 groups, in Table 2.

Table 2: Age/gender bands considered

Band code	Age/gender	Average % in this band in the GP
Band 10	age < 3	3.09%
Band 20	age >= 3 and age < 18	17.58%
Band 30	age >= 18 and age < 35 and sex = Male	10.23%
Band 35	age >= 18 and age < 35 and sex = Female	9.84%
Band 40	age >= 35 and age < 48 and sex = Male	10.48%
Band 45	age >= 35 and age < 48 and sex = Female	9.92%
Band 50	age >= 48 and age < 70	27.11%
Band 60	age >= 70	11.74%

Apart from gender and age, research and clinical judgment suggest that factors such as education, employment and income do have an impact on the health condition of an individual. The proportion in the population in each geographical area that suffer each type of deprivation (e.g. education, income, living space, etc.) have been computed by the Department for Communities and Local Government in the UK and corresponding indices of deprivation by Lower Super Output Area (LSOA) are available[1]. There are seven "domain" deprivation indices that are used to construct an overall index of multiple deprivation (IMD)[2].

In order to reflect the level of deprivation of the population in the list of each GP practice, we adopted the following procedure: each person brought to the practice the value of the index of multiple deprivation of the geographical area where they reside. We deemed that the index values above a certain threshold would reflect high health dependency while those below not. Percentile values were determined at national (England) level. Then the number of people in each age/gender band at each GP was subdivided into two subsets, one subset containing those having deprivation index above some given percentile threshold, and the second those having an index value below that threshold. Therefore, our output variables are of the type: *people in age band k living in LSOAs where the index of multiple deprivation is below the percentile z*, and *people in age band k living in LSOAs where the index of multiple deprivation is above the percentile z*. The age bands considered were those in Table 2, and the percentile considered was the 80% (this choice was done after trying several alternatives, and applying regression and DEA models to several model specifications, including trials on different deprivation indexes).

DEA Models

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[1] For more details on the deprivation indices see: www.communities.gov.uk/communities/neighbourhoodrenewal/deprivation/deprivation07/).

[2] Deprivation indices are only available for 2004 and 2007. We used the 2007 indices. It should be noted that the higher the value of an index the higher the level of the deprivation concerned.

Each GP unit will be referred to as a Decision Making Unit or (DMU). Consider for DMU j (j = 1, ..., n) a vector $\mathbf{x}_j = (x_{1j}, x_{2j}, ..., x_{mj})$ reflecting *m* inputs consumed for producing a vector of *s* outputs $\mathbf{y}_j = (y_{1j}, y_{2j}, ..., y_{sj})$. Consider also, that prices of inputs are known and given by a vector $\mathbf{p}_j = (p_{1j}, p_{2j}, ..., p_{mj})$. The cost efficiency model for each DMU o is the solution of the linear program in (1), where input quantities x_i and the intensity variables, λ, are taken as the decision variables while prices are considered exogenous (see e.g. Thanassoulis et al., 2008):

$$Min\left\{ c = \sum_{i=1}^{m} p_{io} x_i \ | \sum_{j=1}^{n} \lambda_j x_{ij} \le x_i, \sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{ro},\ \lambda_j, x_i \ge 0 \right\} \quad (1)$$

The optimal solution from model (1) yields the minimum cost (c^*) at which DMU o could secure its outputs y_{r0}. Cost efficiency is obtained as the ratio between the minimum cost and observed cost, (c^*/c^o). This ratio measures the extent to which a DMU needs to change its inputs in order to become cost minimising, given the prices it faces. Reduction in costs is considered attainable in a two-stage process: (i) reducing the volumes of inputs pro-rata to achieve the production frontier; (ii) change the mix of inputs, if necessary, in a way that this mix is the most favourable given the input prices faced by the DMU. The first way to reduce costs is called *technical efficiency*, and the second is called *allocative efficiency*.

Technical efficiency is obtained as the optimal solution of model (2).

$$Min\left\{ \theta \,|\sum_{j=1}^{n} \lambda_j x_{ij} \le \theta x_{io}, \sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{ro},\ \lambda_j \ge 0 \right\} \quad (2)$$

Since cost efficiency is the product of technical and allocative efficiency, from the optimal solution of (1) and (2) we can retrieve allocative efficiency as:

Allocative efficiency = cost efficiency/technical efficiency

Clearly, apart from the above mentioned we can also think of a third way to reduce costs, which is to reduce the prices at which the inputs are secured, if the DMU has some control over this. If prices are to some extent controllable by the DMU, we can also compute *price efficiency*. This has been done previously by Fare et al. (1990, 1994) and addressed recently by Tone and Tsutsui (2007). In this paper we investigate price efficiency through a modification of this latter approach as there is a possibility GP units can alter care providers on price.

The approach followed to find price efficiency starts with the traditional model (1) for finding the referral volumes that minimise costs given the prices a unit faces. Then taking the optimal referral volumes from this model (x_i^*) we compute the corresponding cost levels: $C_i^T = p_i x_i^*$, for inpatient and outpatient referrals respectively. Next we use these cost levels in model (3) below.

$$Min\left\{ \sum_i C_i \,|\sum_{j=1}^{n} \lambda_j C_{ij}^T \le C_i, \quad \sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{ro},\ \lambda_j \ge 0 \right\} \quad (3)$$

Model (3) seeks to minimise the aggregate cost of inpatient and outpatient referrals of practice *o*, so that its list patients y_0 are served taking as reference the correspondences of inpatient and outpatient cost components to list levels other practices have. When model (3) does identify cost savings beyond those yielded by model (1) the savings can only be through exploiting unit prices, as model (1) exhausts savings possible for the list population of practice o treating its unit prices as given.

Let us denote C_V^* the minimum cost for practice o yielded by model (1) (i.e. taking its own inpatient and outpatient unit costs as given). Let the minimum cost yielded for the same practice by model (3), be denoted C_P^*. Then the overall cost efficiency inclusive of price efficiency is C_P^* / C_o, the denominator being the observed cost of referrals at practice o. This ratio can be seen as the product of cost efficiency exclusive of price efficiency C_V^* / C_o, and **price efficiency** C_P^* / C_V^*, since we have: $\frac{C_P^*}{C_o} = \frac{C_V^*}{C_o} \times \frac{C_P^*}{C_V^*}$. Clearly in this decomposition we are assuming that volumes are changed first and prices are changed residually (in search for even lower costs). The results would change if the assumption was that prices should change first and only after that volumes could change residually. We do not pursue this avenue here.

Note that to all DEA models used in this analysis weight restrictions were added to reflect different degrees of importance of outputs. An analysis of inpatient costs per age band in Table 2 revealed that costs are very different between age bands, with elderly people costing more, female costing more than males, and costs for more deprived people being higher than those for less deprived population. Therefore, weight restrictions between outputs were imposed to guarantee that the relationship between weights posed on outputs did not contradict the importance (in cost terms) of that output.

Main Results

Before producing results on the cost efficiency of GP units and its decomposition we investigated issues of returns to scale of GP units. The 75 practices that compose our data set have very different sizes, and it is important to ascertain, before any comparison is made, if large and small practices are comparable (this would be so if we assume that what happens at a small scale practice can be replicated in a large scale practice without any gain or loss accruing from higher volumes of service).

Intuitively we might expect scale economies to apply so that the larger the practice in terms of list size the lower the referral costs per listed person. This could be so for example because larger practices may have more nurses and specialist doctors (e.g. obstetricians) who could deliver care more economically within the practice rather than referring certain patients to hospital. Figure 1 shows total inpatient and outpatient cost per person on the practice list against list size. The data are for the year 1/4/07 to 31/3/08. Average costs in Figure 1 appear to be stable ranging from 328.73 pounds per person for the smallest practices with list size below 3000 to 338.8 for practices with list size between 7000 and 10000 persons. Figure 1 does not control for the mix of individuals by the health bands of Table 2. In spite of that, it is clearer from Figure 1 that variation in cost per list person is much larger for practices with small list sizes and reduces as the list size increases. Indeed, smaller practices are the ones showing both the lowest cost and also the highest cost per list patient. This large variability may be because the one year time span of our data may not be long enough to capture the more rare diseases or treatments that may arise in some but not all of the small GP units. Referral costs relating to such rare diseases could average out across large list sizes within each year but not so within a small list size and within one year.

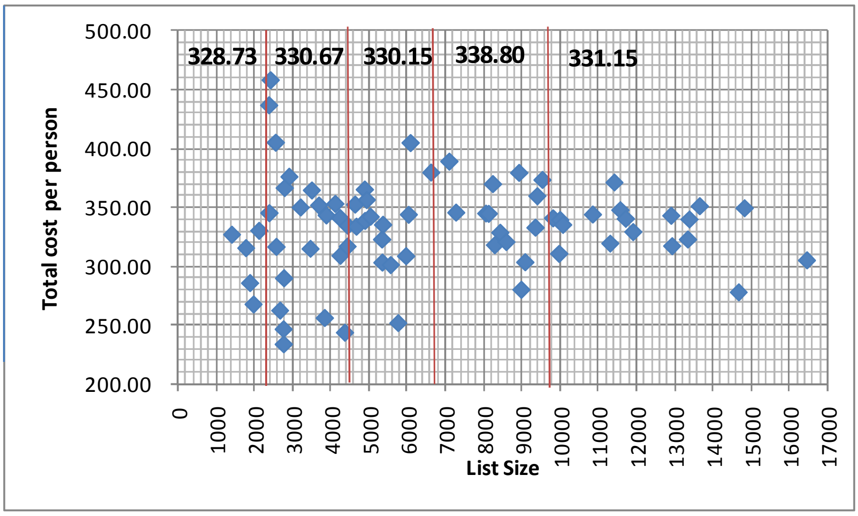

Figure 1: Average cost per list patient

In view of the foregoing findings GP units were compared under the assumption of Variable Returns to Scale (**VRS**). The VRS assumption permits economies or indeed diseconomies of scale with list size. As such, it only permits comparison between GP units of similar scale size.

The DEA analyses have made it possible to break down the overall potential for savings on referral costs as follows:

- Savings from eliminating technical inefficiency (captures the extent to which a GP practice could reduce referral costs through reducing in and out patient referral cases keeping their mix constant - this is achieved as a solution to model (2));
- Savings from eliminating allocative inefficiency (reflects the extent to which a GP unit can further reduce its in and out patient referral costs by adjusting their mix to better exploit the unit cost it faces per in and out patient case and (achieved by comparing this the solution of models (1) and (2));
- Savings from eliminating price inefficiency (reflects the extent to which a practice which has already exploited the foregoing two components of savings can realize additional savings by looking for lower inpatient and outpatient unit costs – this is achieved as a solution to model (3)).

Table 3**Error! Reference source not found.** shows the scope for savings broken down into its constituent components. The first point worthy of note is that in Table 3 we identify potential savings of £30.83m, which is made up of three components. Some £15m of these savings are possible by simply lowering the volumes of referrals without changing the mix between in and out patients. This component of £15m, as noted above, would be perhaps the first one to be sought since it accepts implicitly the choice a GP has made between inpatient versus outpatient referral and simply suggests that non-benchmark practices have on the face of it more referral cases than their benchmark counterparts when we control for list population characteristics. The next component of £6.42m is achievable by switching from inpatient to outpatient in order to best exploit differences in the related unit costs (or prices). Finally there is a component of £9.41m of potential savings that is achievable through GPs choosing judiciously their providers to attain prices that best match the inpatient and outpatient cases identified above for attaining the foregoing two components of savings.

Table 3: Scope for savings in referral costs by component, net of economies of scale.

	Grand total	Technical eff. savings	Allocative eff. savings	Price eff. savings
(£m)	30.83	15	6.42	9.41
(% of actual total referrals cost)	18.20	8.85	3.8	5.55

Benchmark GP units were identified for each of the above efficiency assessments and GPs showing the highest scope for savings in each dimension could be compared to the benchmark units used in the reference set of their efficiency assessment.

As can be seen in Table 3 the largest component of potential savings at a practice is through reducing the volume of referrals rather than through altering their mix or seeking lower provider prices, though at some practices the latter two components can be quite significant too.

Table *4* shows referrals per 1000 list persons at certain non benchmark practices and at some of their corresponding benchmark practices. It is very evident in this table that referral volumes are much higher at the non benchmark practices compared to their benchmarks. For example, benchmark G44 has almost the same list size as non benchmark G68. Yet G44 has only 129 inpatient referrals per 1000 in the list population compared to 208 at G68. Similarly G44 has 805 outpatient referrals per 1000 list population compared to 1023 at G68.

Table 4: Referral Volumes at the 3 GPs with the Largest Scope for Savings in technical efficiency and a sample of their Benchmarks

GP	Scope to save radially in and out patient referrals (% of TC)	TC	List size (total)	Inpatient referrals per 1000 list population	Outpatient referrals per 1000 list population
Practices with largest scope for reducing referral volumes					
G45	36.89	1,281,258.47	3,519.00	243.82	1,214.83
G8	26.29	3,389,944.23	8,948.00	241.17	1,091.31
G68	26.13	1,100,569.55	2,930.00	208.19	1,023.55
Sample **benchmark** practices for the above non benchmark practices					
G40	-	4,077,506.31	14,696.00	165.83	813.69
G44	-	649,911.87	2,786.00	128.86	805.81
G13	-	2,518,018.96	9,004.00	162.48	773.88

Table *4* does not allow for gender, age and deprivation of the list population, which may explain to some extent the higher referral volumes at the non benchmark practices. However, G44 does have list patients with high deprivation and these factors have been taken into account by the actual DEA model, which still suggests that the differences in age, gender and deprivation between the list populations of the non benchmark practices and their benchmarks do not explain the differences in referral rates.

In the comparative assessment of GPs that considers changing the mix between inpatient and outpatient referrals for the current prices of each practice, we produced targets for GPs to achieve after changing the volumes radially. Table 5 summarises the information obtained for the 75 GPs, where TVI (or TVO) is the estimated volume for inpatient (or outpatient) referrals under the minimum cost model (1), which seeks to exploit differences between in and out patient prices. The estimated values in Table 5 consider changes in mix after technical efficiency savings have been attained.

Table 5: Changes in referrals to achieve minimum cost (model (1)), after radial volume savings have been achieved

Target Level/Observed Level		**Cases and Ratio TVI/VI**	**Cases and Ratio TVO/VO**
>1	# cases	13	43
	average	1.006	1.033
<=1	# cases	46	16
	average	0.906	0.904
=1	# cases	16	16
	average	1.000	1.000

So far as inpatient referrals are concerned 13 GPs require a rise (of 0.6% on average) to attain the savings in question, while 46 practices need to reduce the volume of inpatient referrals by an average of 10%. In contrast so far as outpatients are concerned 43 practices should raise volume by, on average, 3.3% while 16 other practices should reduce their volume by 10%. Some 16 practices appear to have the right mix of inpatient to outpatient referrals for the purposes of minimising the two cost components in question. Thus in general most savings in these two components can be achieved by a reduction in the volume of inpatient referrals, and increase in volume of outpatient referrals. This suggests that after reducing volumes radially, GP units face some mix inefficiencies, where in general they tend to have excess of inpatients and slack of outpatient referrals (the results suggest that some mix inefficient GP practices should do the trade-off between inpatient to outpatient referrals).

Finally with the price efficiency model we tried to seek for further savings in costs after volume savings (radial changes and mix changes) have been considered. In Figure 2 the mean inpatient and outpatient volumes, VI and VO respectively, mean unit cost of inpatient and outpatient referrals, PI and PO respectively, and the mean total referral cost for inpatients (CI) and outpatients (CO) are shown for benchmark practices and non-benchmark practices. Values have been normalized by the price efficient benchmarks (strong line). Figure 2 shows quite clearly that while volumes of inpatient and outpatient referrals at non benchmark practices are on average less than 5% above those of the benchmark practices, inpatient referral costs (CI) are about 13% higher on average than those of the benchmark practices. This is turn is primarily due to inpatient referral prices at non benchmark practices being about 10% higher than at benchmark practices.

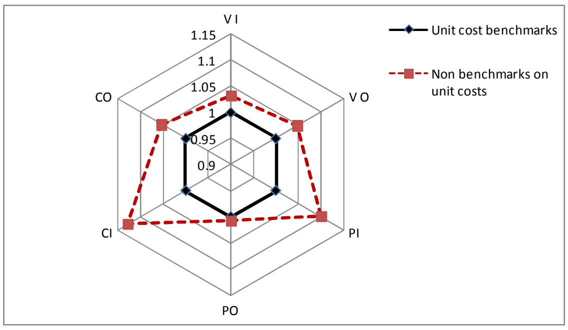

Figure 2: Contrasting benchmark and non benchmark practices on price assessment

Conclusion

This paper has analysed the potential for reducing referral costs in English GP units when the characteristics of the population served by the practices is accounted for. Results suggest that substantial cost reductions could be achieved through the reduction in the volume of referrals, through changes in the mix between inpatient and outpatient referrals, and through changes in the prices of the referral service provided by hospitals. This analysis has been done in conjunction with a doctor from the primary care trust involved in this analysis and the results were considered relevant for the management of GP units, since strong inefficiencies were revealed by some practices. Clearly several reasons may exist to justify such inefficiencies (e.g. small scale practices, few nurses and other personnel, health severity conditions of patients, etc.), and these reasons should be looked at within GP units. This analysis will continue in a more detailed study where the actual patients served by the practice and the severity of their health conditions will be considered rather than the population served by the practice.

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