2. **Basic Information on the PI, Co-PIs and other main participants** (separate page).

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<th>Title of Project:</th>
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<tr>
<td></td>
<td>PI</td>
<td>Weiyan Jian</td>
<td>Male</td>
<td>34</td>
<td>Ph.D</td>
<td>Lecturer</td>
<td></td>
<td>Health policy and management</td>
<td>Conceptualize and design the project, oversee the data collection, analysis, and knowledge transfer activities, and lead the writing of the reports and academic publications.</td>
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<td></td>
<td>Co-PI</td>
<td>Winnie Yip</td>
<td>female</td>
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<td>Ph.D</td>
<td>professor</td>
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<td>Co-PI</td>
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<td>participant</td>
<td>Ming Lu</td>
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*only individuals who invest more than 5% of their work time of the project should be listed*
4. Abstract (under 300 words)

Background: Despite substantial new government financing and almost universal insurance coverage, patients in China still face significant financial risks for health care because health expenditure has grown even faster than insurance reimbursement. Importantly, quality of care does not measure up to the resources spent. To address these problems, the Chinese government has announced its plan to reform provider payment methods for public hospitals, moving from fee-for-service (FFS) to methods such as global budget, capitation, and Diagnosis-Related-Groups (DRG). Beijing pioneered the development and implementation of DRG in 2011 in six hospitals to provide lessons for other locales.

Goal and objectives: To evaluate the impact of Beijing’s DRG payment reform on health expenditure and quality of care and identify barriers and pre-conditions necessary for successful implementation of DRG reform.

Methods: Using hospital discharge data provided by Beijing’s Health Bureau, inpatient claims data provided by Beijing’s Health Insurance Center, and inpatient and outpatient expenditure data provided by Beijing Health Insurance Center for 2009-2014 (three years pre- and post-reform), a differences-in-differences (DD) design with propensity score matching (PSM) will be used to evaluate the impact of this reform on medical expenditure, treatment pattern, and medical service quality. Key informants interviews will be conducted with policy-makers to identify design and implementation barriers of DRGs. Senior and middle hospital management and medical personnel will be interviewed to understand how DRG reform affects internal management of public hospitals and incentives, income for individual staff and other implementation barriers.

Outcome measures and implications: Outcome measures include health expenditure, treatment pattern, and service quality. Intermediary outcomes include hospital internal management arrangements and policy environment. Findings will help Beijing make mid-course refinement for this policy but more importantly, provide lessons for nation-wide scale up of DRGs and contribute to a key aspect of public hospital reform in China.

5. Background and Significance

In recent years, China has been investing considerable effort and resources into improving
health care accessibility and affordability (the problem of ‘kan bing nan, kan bing gui’) [1, 2]. Of the RMB 1.4 trillion the Chinese government had invested into health care between 2009 and 2011, 50% of the amount was allocated to subsidize enrolment in social health insurance schemes [3]. As a result, China’s health insurance coverage had an increase of 12% during this relatively short time period to covering over 90% of its total population [4, 5]. In spite of this, there has been no obvious reduction in the financial risks posed to those who are ill [6].

A key attributor for this peculiar situation was the rapid increase in health expenditure [3, 7]. In the six years between 2003 and 2009, health expenditure per capita grew an average 14.23% per year while GDP per capita increased by an average of 12.45% [8] As a result, even though health insurance has increased the share of total health expenditure, patients’ out-of-pocket payment as a share of their household income (or consumption expenditure) has remain static at best, and in some cases, increased [9, 10]. Both economic theories and empirical evidence suggest that when insurance expansion occurs within a fee-for-service (FFS) payment system, providers are more inclined to give patients more intensive treatment (a phenomenon known as ‘supply-side moral hazard’) [11], leading to health expenditure growth.

To address this problem, the Chinese government has called for a move from a purely FFS payment system to a mixed system that includes more prospective payment methods, such as global budget, capitation, case based payment [1-2]. This in turn forms the basis of the public hospital reform agenda.

International experience has repeatedly shown that clinician behaviors are influenced by provider payment methods, and provider behaviors directly affect patients’ health outcomes [11, 12]. While prospective payment methods give hospitals incentives to reduce unnecessary services/drugs, they could also give incentives for hospitals to refuse care to severely ill patients (a phenomenon known as ‘risk selection’); thus lowering health care accessibility to those most in need of treatment [11, 13]. For this reason, countries that are planning and/or undergoing payment methods reforms have been giving considerable attention to balancing the potential positive and negative effects of different payment methods on provider behaviors [14].

Diagnosis-related-group (DRG) is a sophisticated form of case-based payment, which pays hospitals a fixed amount per admission, but the rates vary by groups of diagnoses and (or) procedures (thus the name, DRG) [15]. This payment method is expected to help reduce medical
expenditure and at the same time avoid potential risk-selections [15, 16]. DRG is however very demanding in terms of completeness of diagnostic/procedures data, information system capacity in the storage and retrieval of patient records, and coordination between different hospitals. Beijing is the first place in China that has adopted a DRGs payment so far, making the Beijing experience a unique and valuable case study for DRGs payment reform elsewhere in China. In Beijing, Diagnosis-related Groups (BJ-DRGs) was developed drawing upon the case-mix frameworks in United States (AP-DRGs) and Australia (AR-DRGs) [17]. Since October 2011, BJ-DRGs has been trialed in six tertiary general hospitals for inpatient covered by the Beijing Employee Basic Health Insurance Scheme [18].

China’s recent experience in other case based payment reform (e.g. fixed rates payment per admission regardless of diseases) has not been effective in changing provider behavior [19]. The lack success in previous experience was attributed to factors including: 1) the admissions subjected to case based payment only represented share of the total hospital revenue that is too small to have any impact on provider decision making [20, 21]; 2) the case based payment included mainly common health conditions with no complications, which in turn provide hospitals with the flexibility of by-passing the case-based payment system by “upcoding” cases to health conditions that are still in the FFS [22, 23].

The current Beijing DRGs payment reform has incorporated lessons drawn from prior case payment experiences and has put in place mechanisms that tackle the two issues above. A comprehensive approach was taken in the design of the payment system to cover all acute conditions that require hospitalization [17]. To minimize opportunities for upcoding, conditions with similar clinical processes are grouped together under one DRG, and conditions with different levels of severity assigned with different DRG codes [17]. Furthermore, admissions subject to DRG payment represent over 40% of pilot hospitals’ revenue from insured patients [18]. This in turn places considerable more pressure on provider decision making relative to previous case payment reform attempts.

In order to path the path for the DRGs reform, considerable preparation was made improving Beijing’s organizational management and information systems in the lead up to the introduction of BJ-DRGs [24]. Because the reform involves many government departments, a committee responsible for coordinating and advancing the reform was established in 2007, and is comprised of
Beijing Health Bureau (in charge of quality of care), Beijing Human Resources and Social Security Bureau (in charge of social health insurance), Beijing Development and Reform Commission (in charge of drug pricing), and Beijing Finance Bureau (in charge of the financial subsidies of public hospitals) [24]. On a technical level, in 2007, standardization of inpatient discharge data was introduced for all major hospitals in Beijing, requiring diagnoses to be consistently coded according to ICD-10 while service procedures are consistently coded according to ICD-9 [25, 26]. In addition, as the DRGs payment system requires a considerable amount of inpatient service information for the assignment of DRGs and the calculation of the co-payment amount for each case, considerable modifications have been made to the accounting and information management systems of the DRGs pilot hospitals to ensure that the copayment amount is confirmed for each patient at the time of discharge [24].

Since 2003, the Beijing Health Bureau has collected a large amount of electronic patient discharge data, the completeness and reliability of this data have been considerably improved since 2007 with the standardization process described above. Similarly, the Beijing Health Insurance Center has detailed records of all claims information, including expenditure per admission and details of drugs prescribed medical materials for each inpatient. This currently under utilized data is a valuable measure of changes in provider treatment behaviors, and could prove to be a useful data source for health system evaluation (including treatment quality) in Beijing well into the future.

Evidently, the DRGs payment reform in Beijing has employed a more systematic attempt in design than previous case based payment reform elsewhere in China. Notably, the effectiveness of DRGs in containing medical expenditure is subject to continuous debate [27, 28]. In the US where DRGs have been implemented in Medicare for 30 years, medical expenditure has continued to increase at a fast rate over this period [29]. In contrast, DRGs has been effective in stabilizing growths in health care costs in countries like Australia, Germany and France [30, 31, 32]. The mixed evidence from these countries together indicates the effectiveness of DRGs differs under different contexts.

Investigation into Beijing’s DRGs payment reform could provide a valuable case study to this debate and enhance our understanding of the effects of DRGs as a payment policy in a developing country context. It could also be a meaningful contribution to both payment system theory and health policy practice. So far, Beijing’s DRGs payment reform has not been evaluated. The
proposed research will fill this gap in knowledge. Project findings will not only help inform the Beijing municipal government in terms of future directions of the reform, but also be valuable for informing the usefulness of DRGs as a way of improving providers’ behavior in other parts of China. In addition, such lessons will contribute towards the accumulative knowledge of DRGs globally, and could have important relevance especially to other developing countries.

6. Goal and objectives

Overall goal of the project:

The overall goal of this study is to evaluate the impact of the DRGs payment reform in Beijing on healthcare quality and patients’ financial risks. In identifying the strengths and limitations of the current state of the DRGs payment relevant policies, this project aims to contribute to the further improvement of DRGs payment as a mechanism for containing medical expenditure. Project results will be shared and discussed with policy-makers in the relevant government departments (including the Health Bureau, and the Bureau of Human Resource and Social Security), and hospital management. The project also aims to use Beijing as a case study of DRGs payment design and implementation for other regions of China. Project results could also hold lessons for DRGs payment design and implementation for other low- and middle-income countries.

The project has two phases: a pilot phase and a main study.

Objectives for Pilot Study:

(1) To review relevant theories and empirical literature that will guide the development of the research protocol; and

(2) To test and refine the study protocol. For the qualitative component of the project, this involves developing and pilot testing the protocol for key informants interviews. For the quantitative component of the project, this involves selecting a small sample of hospital discharge data to test and refine the quantitative model.

Objectives for Main Study:

(1) To evaluate the impacts of the DRG reform on medical expenditure, inpatients’ financial risk, treatment pattern, and medical service quality;
(2) To assess the ways in which providers engage in potential gaming behaviors as responses to the DRG payment reform (e.g. early discharge and readmission, upcoding and cost-shifting);

(3) To assess the effects of DRGs payment reform on hospital internal management, internal incentives for clinicians and clinician income;

(4) To examine the issues encountered in the design and implementation of the DRGs reform (e.g. problems in upgrading Beijing’s health information system, price policy and the dispersion of regulation power for public hospitals), and the ways in which the relevant government departments have dealt with (or are planning to deal with) the issues;

(5) To inform the relevant health and finance sectors within the Beijing Municipal Government and the Central Government of the impact of the current DRGs reform, potential policy implications, and areas of improvement.

7. Theoretical model and Hypotheses

Theoretical Model:

Our theoretical model assumes that hospitals maximize profits (revenue net expenses). The FFS encourages prescription of unnecessary services because hospitals are paid in full by insurance and patients; as such, they do not bear any financial risks for over prescribing services to patients. The prospective payment scheme of the DRGs reform is designed to introduce an element of financial risks to hospitals as a way to reduce over-servicing. Under this new system, hospitals receive a pre-determined fixed amount deemed sufficient for the provision of necessary services for each admission, and they are left to bear the financial risk of prescribing services that exceed this amount. The risk, in turn, is an incentive for reducing the amount of services provided.

Questions thus arose regarding (i) the ways in which hospitals pass on the DRGs incentives to clinical departments that directly regulate the financial incentives of individual clinicians who are the main decision makers in treatment choices; and (ii) the ways in which clinicians respond to these new incentives in their treatment decisions. In mainland China, clinicians’ income has two components: (i) a basic salary component which is set by the Beijing Municipal Government and across all hospitals; and (ii) a variable bonus component that is independently determined by the hospital, and accounts for more than 50% of clinicians’ total income. Two stages are involved in the allocation of clinician bonus. Firstly, a portion of the hospital’s gross margin is redistributed to the
clinical departments according to their respective “performances”. Each department then allocates a bonus to each of their clinicians depending on each person’s performance.

Underlying the design of the bonus system is a principle of ‘incentive compatibility’ between hospital and hospital department, and between departments and clinicians. Under FFS, the more services clinicians provide, the higher the hospital revenue. Hospital managements therefore have been encouraging clinical departments to provide more services; and the encouragement is then passed on from department to clinicians. The DRGs payment reform is designed to change these internal incentive arrangements by rewarding hospitals for reducing cost per admission. In the intended scenario, this (external) modification of payment policy necessitates systemic responses from hospitals for which new internal incentive arrangements are to be created. This new order of incentives will be focused on controlling treatment cost per admission instead of increasing service volume. As hospitals modify funding for departments based on this principle, and departments to clinicians in terms of individual bonuses, behaviors of clinicians are likely to change, leading to changes in patients’ healthcare outcomes (see Figure 1).

Figure 1Theoretical model of the proposed study
Ideally, the reduction in service will apply only to unnecessary services. In this scenario, DRGs would have served to correct over-servicing and contain medical expenditure without compromising service quality. If however, the reduction applies to necessary services, treatment quality could be severely compromised. The development of modern health management system in China has a relatively short history, the regulation of hospitals by government and other administrative agencies is not yet mature. Within the context of weak regulation, DRG payment could have provided the incentive for excessive cuts in medical services (including necessary services), which could in turn lower the overall quality of services.

The effectiveness of the DRGs scheme can also be affected in situations where DRGs covers only a portion of inpatient cases, leaving the rest of the inpatient revenue and the entire outpatient revenue are still under paid by FFS (like the case in Beijing’s DRGs payment reform). Such scenarios give hospitals the flexibility to respond to the DRGs payment reform by avoidance or ‘gaming behaviors’ that are counterproductive to the reform. Such behaviors include 1) assigning patients a diagnosis code outside the DRGs list (up-coding) so as to bypass DRG-based payment; 2) cost shifting to services still paid by FFS, such as outpatient; and/or 3) discharge patient early and then re-admit them since hospital revenue increases with number of admissions (see Figure 1).

Primary Hypotheses:

(1) The shift from FFS to DRGs will lead to changes in the internal incentive arrangements between hospitals and their clinical departments, and between clinical departments and clinicians re-structured around cost containment (per-admission) instead of service volume maximization. These changes will be reflected in the written/unwritten internal hospital polices for assigning budgets to clinical departments, and bonuses to clinicians.

(2) Compare to FFS, DRG will result in lower expenditure per admission, shorter length of stay, and reduced intensity of services (such as use of diagnostic tests, expensive drugs);

(3) Compare to FFS, DRG will reduce the quality of care.

Secondary Hypothesis:
The introduction of DRGs might lead to provider gaming behavior in the forms of: a) increase in readmissions; b) upcoding; c) cost-shifting (e.g. services that were previously performed during hospitalization, such as pre-surgery examination, could be shifted to outpatient services as a way for hospitals to by-pass the reform.

8. Methods

Setting and sample

The proposed study involves the six hospitals that have been targeted for Beijing’s DRGs payment reform (henceforth referred to as DRGs-hospitals), and related departments within in the Beijing Municipal government. A mixed methods approach will be adopted to provide a holistic and in-depth understanding into some of the progress and outcome of this reform, and some of the underlying factors of the outcome.

The quantitative component of the study will be comprised of patient records from 12 hospitals: the 6 DRGs hospitals and 6 control hospitals that are not undergoing the payment reform but matched to the 6 DRGs hospitals based on size (beds, staff, outpatient visits and inpatient discharges per year), clinical departments the hospitals have; types of conditions treated and hospital location.

All discharge data of DRGs payment cases will be collected to form the study groups. An ‘internal control group’ will be formed using discharge data from self-paying cases matched in diseases to the DRG-payment group (i.e. patients without insurance and do not fall under the DRGs payment system) from the same hospitals. From the control hospitals, an ‘external control group’ will be drawn from discharge data from patients matched in diseases that are covered under the Beijing Employee Health Insurance Scheme. The sizes of study groups, internal control groups and external control groups are anticipated to be amount to 5,000, 4,000, and 5,000 discharges per hospital per year, respectively. Thus, the annual sample size will amount to approximately 84,000 cases over 6 year (2009-2014), giving a total sample size of 504,000 cases for the quantitative analysis.

The qualitative research component will be comprised of Key Informants interviews, including interviews with officials from the Beijing Health Bureau, the Beijing Bureau of Human Resource and Social Security, and the Beijing Health Insurance Center who are in charge of the
DRGs reform, as well as hospital management and physicians from the six DRGs hospitals. The number of key informants from the government sector will be approximately 2 officials who take part in the policy-making of DRGs payment and/or implementing this policy from each of the above departments. From hospital management, interviews will be sought with hospital staff in charge of the management of health insurance, healthcare quality, and the allocation of department and clinician bonuses. Approximately 4 informants will be interviewed in each hospital, amounting to a total of 24 informants across the six hospitals. Interviews with clinicians will focus on two hospital departments with the highest number of discharges covered by the DRGs payment. In principle, one senior and one junior clinician from each of these departments per DRGs hospital will be interviewed. This gives a total of approximately 56 key informants interviews will be conducted (including 6 government official, 24 hospital management and 24 clinical doctors. The initial interview will be conducted in the first year of the study period, and a follow-up interview with the same informants will be conducted in the final year of the study in order to evaluate the progress of the reform over the study period. In total, approximately 112 interviews will be conducted, though the final sample size could be slightly reduced as follow-up interviews will ceased at the point of information saturation.

Procedures

Four databases will be used for the quantitative component of this project:

1. The Discharge Database administered by the Beijing Health Bureau, which contains more than 160 variables including primary diagnosis of patients, secondary diagnosis, procedures, various types of medical expenses, and patients’ age, gender and other basic information.;

2. The Inpatient Expenditure Detail Database (IEDD) administered by the Beijing Health Insurance Center, which records claims information for each admission (e.g. total expenditure, itemized expenditure on drugs, procedures, tests and their rebates);

3. The Outpatient Expenditure Database (OED) administered by the Beijing Health Insurance Center, which records outpatient expenditure for every outpatient consultation; and

4. The Monitoring Record of Discharge Data (MRDD) administered by the Beijing Health Information Center (BHIC), which contains results of the annual quality audits of hospital discharge data conducted by the BHIC across all hospitals in Beijing, as well as the initial
diagnosis and procedural coding from the treating hospital for each audited case.

We will draw data from these four databases to test the hypotheses above. The relationships between the project objectives, hypotheses, quantitative models and databases are shown in Table 1.

Since 2007, standardization of discharge data has been carried out across Beijing municipality. This has allowed the unification of hospital discharge data across the municipality, and increased the variables needed for DRGs grouping.

Beijing has nearly 10 years of experience using electronic claim data for the management medical insurance. Medication and medical services used by patients forms the foundation of medical expenses, and is the focus of medical insurance. The cumulative experience in the administration of this payment method is anticipated to greatly reduce the possibility of error in the data. For all of the reasons above, we believe the reliability and quality of the information both in terms of the discharge data and the claim data we will be obtaining for this study.

For the qualitative component of the project, document analysis and Key Informants interviews will be used to answer objective (3) and (4). Documents relating to the DRGs-payment reform will be collected from the relevant government websites. Information in these documents will inform the development of the interview protocol. Key Informants from the relevant government sectors involved in the DRGs-payment reform, hospital management and clinicians from the DRGs-payment reform hospitals will be interviewed to give their different perspectives on the issues they have encountered so far following the DRGs payment reform. Key Informants from the relevant government sectors will be interviewed for their views on the key successes and barriers of the implementation of the DRGs-payment policy, and their plans and approaches for improvement. Informants from hospital management will be sought at the levels overall hospital management and clinical departments with large DRGs-payment loads. Interviews with these informants will focus on management’s views on the usefulness of DRGs-reform, hospital policy changes (internal contract) in response to the reform (external contract), and the adaptation of these policy responses by clinicians (behavioral change). Internal hospital documents detailing any policy responses to the reform will be sought from the informants during the interviews. Finally, the reasons behind Key Informants’ views and attitudes towards the reform and internal policy and behavioral changes will also be explored. These will be explored at two time intervals: (i) the initial
Interviews will be audio typed and transcribed in full. Where audio recording is not possible, detail notes will be taken by the interviewer, and turned into electronic files. Data from policy documents and interview transcripts and notes will be entered, thematically coded and managed using NVivo. Data will be triangulated and thematic analysis will be conducted using a grounded theory approach.

**Instruments**

1. In the analysis of patient discharge record, BJ-DRGs and Charlson Comorbidity Index (CCI) will be used as risk-adjustment tools to establish comparability between cases of similar clinical conditions and severity. BJ-DRGs is the local developed case-mix, as such, it is suitable to the data environment of Beijing. BJ-DRGs take into account different diagnoses and procedures, age, gender, body weight (for infants), complications and comorbidities to adjust the risks of different conditions. Empirical findings have indicated that the risk-adjustment performance of BJ-DRGs is similar to other matured DRGs versions, like those used in the US (AP-DRGs) and Australia (AR-DRGs). CCI is a widely used international instrument for risk-adjustments that is marked by its meticulous scoring methods for different types of comorbidity that in turn reflects case severity. In contrast, BJ-DRGs’ uses a more simply approach in scoring comorbidities, but take into account factors not considered by CCI, including different surgical procedures and patients’ gender, age, birth weight (infant cases) and other factors. The two instruments are thus complimentary to each other. Combining BJ-DRGs and CCI in the proposed study would thus improve the effectiveness of risk-adjustments.

2. For the qualitative component of the project, an interview protocol will be developed around the research goals and hypotheses. For Key Informants from the government sector, the interviews will focus on the following themes: (1) the ways in which the preparation of DRGs payment might be affected by factors such as the pre-existing price policy health insurance administration structure and medical information systems of the public hospitals that are designed around pay-for-service payment; (2) the ways in which such factors could have negatively affected the implementation of the DRGs payment; and (3) the way in which the Beijing Municipal
Government has been (or plan to be) dealing with the barriers. In terms of interviews with hospital management and clinicians, interviews will be guided by Incentive Compatibility Theory: (1) how the external payment reform influence the hospitals internal incentive designs; and (2) how the incentives pass on from hospital to department and then to clinicians.

**Statistical Methods**

Our quantitative empirical strategy is primarily a differences-in-differences (DD) method combined with propensity score matching (PSM). DD compares differences of changes in the outcome variables before and after the reform, controlling for other relevant factors (e.g. time trend, age, gender, complications, etc.). The analysis is operationalized as:

\[ Y_i = \alpha + \beta_1 reform_i + \beta_2 hosp_j + \beta_3 re_{-hosp} + \delta X_i \quad (1) \]

in which \( Y \) represents inpatient service outcomes; \( reform \) is a dummy variable where 1 represents post-reform data (data from October 2011 to December 2014), and 0 represents pre-reform data (data from January 2009 to September 2011); \( hosp \) is a dummy variable where 1 equals admissions of patients covered by DRGs, and 0 equals self-payment admissions at a DRG payment hospitals (internal control group) or BEBHI admission at a control hospitals (external control group); \( re_{-hosp} \) is an interaction variable between \( reform \) and \( hosp \), and \( \beta_3 \) is the DD estimate that measures the impact of the reform. \( X \) represents a set of control variables, including age, sex, DRG groups and co-morbidity (assessed by Charlson Co-morbidity Index). The unit of observation is admission, in which, \( i \) stands for admission, \( j \) stands for hospital and \( t \) stands for time period.

The PSM modeling we are proposing will be conducted directly at the case level. Taking into consideration that, as a response to the payment reform, DRGs payment hospitals might be selecting different cases to admit than the fee-for-service control hospitals. This could lead to inconsistencies in the case structures of between the DRGs hospitals and the control hospitals. We therefore plan to select the control group from the comparison hospital by using selecting case that match the cases of the “study group” from the DRG hospitals according to variables such as age, sex, type of disease.

In testing Primary Hypothesis (2) -- *i.e.* whether DRGs payment influences the health expenditure, length of stay, and intensity of services change -- \( Y \) in equation (1) represents medical expenditure and its sub-items (drug, lab test, treatment, nursing and so on), or length of stay.
For Primary Hypothesis (3), inpatient mortality and survival time will be used as the indicator measures for healthcare quality. When measuring the mortality, equation (1) is modified as:

$$\ln\left(\frac{P_d}{1-P_d}\right) = \alpha + \beta_1 reform + \beta_2 hosp + \beta_3 re_hosp + \delta X + \epsilon$$  (2)

in which, $P_d$ is the mortality rate of inpatients during their hospitalization.

COX model is used for analyzing the survival time of patients with severe conditions. In this analysis, equation (1) will be modified as:

$$\ln\left(\frac{h(t|x)}{h(t_0)}\right) = \alpha + \beta_1 reform + \beta_2 hosp + \beta_3 re_hosp + \delta X + \epsilon$$  (3)

in which, $h(t)$ represents the probability of death $t$ days following discharged. $h(t_0)$ is the baseline and corresponds to the probability of death when all the explanatory variables equal zero.

To test Secondary Hypothesis, we will analysis whether DRGs payment increases readmission rates, shifting inpatient service to outpatient services, and up-coding rates.

For the analysis of readmission, equation (1) is modified into:

$$\ln\left(\frac{P_r}{1-P_r}\right) = \alpha + \beta_1 reform + \beta_2 hosp + \beta_3 re_hosp + \delta X + \epsilon$$  (4)

in which, $P_r$ is the probability of two-weeks readmission for patients with similar conditions that resulted in hospitalization.

For the cost-shifting analysis, outpatient expenditure data from the Beijing Health Insurance Center will be used. This data will be linked to data in the inpatient and outpatient expenditure databases. More specifically, outpatient expenditure one-week prior to hospitalization will be used as dependent variable for the regression analysis using equation (1).

For the up-coding analysis, monitoring records of discharge data from the Beijing Public Information Center will be used. Equation (1) will be changed into:

$$\ln\left(\frac{P_c}{1-P_c}\right) = \alpha + \beta_1 reform + \beta_2 hosp + \beta_3 re_hosp + \delta X + \epsilon$$  (5)

in which, $P_c$ is the probability of up-coding.

The relationship between data and relevant equations used for each hypothesis is shown in Table 1.
Table 1 summarizes the data and relevant equations used for each hypothesis

<table>
<thead>
<tr>
<th>Objective (main study)</th>
<th>Hypothesis</th>
<th>Method</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective (1)</td>
<td>Primary Hypothesis (2)</td>
<td>Quantitative; equation (1)</td>
<td>Discharge data &amp; IEDD</td>
</tr>
<tr>
<td></td>
<td>Primary Hypothesis (3)</td>
<td>Quantitative; equation (1), (2) and (3)</td>
<td>Discharge data &amp; IEDD</td>
</tr>
<tr>
<td>Objective (2)</td>
<td>Secondary Hypothesis</td>
<td>Quantitative; equation (1), (4) and (5)</td>
<td>Discharge data &amp; OED &amp; MRDD</td>
</tr>
<tr>
<td>Objective (3)</td>
<td>Primary Hypothesis (1)</td>
<td>Qualitative; In-depth interviews of Key Informants</td>
<td>____</td>
</tr>
<tr>
<td>Objective (4)</td>
<td>____</td>
<td>Qualitative; In-depth interviews of Key Informants</td>
<td>____</td>
</tr>
</tbody>
</table>

Abbreviation: IEDD--Inpatient Expenditure Detail Database; OED-- Outpatient Expenditure Database; MRDD-- Monitoring Record of Discharge Data

Limitations

(1) The non-randomized nature of the six DRGs hospitals exposed payment reform might result in sampling bias and make it difficult to control for confounding factors that arise from the complex and rapidly changing health reform environment in China. In order to overcome this limitation, we put in place an internal control group (non-DRGs cases in the same DRGs hospitals matching in disease and diseases severity) and an external control group (non-DRGs cases in control hospitals matching in disease and diseases severity to the DRGs cases) to control for parts of potential confounding variables. In addition, we will collect hospital records spanning 6 years (3 years before and 3 years after the reform) for the Diff.-in-Diff. design to allow the control for the effect of time.

(2) Due to incomplete records of death in Beijing, estimates of ‘survival time following hospital discharge’ will rely on the combination of discharge data and IEDD data. A limitation of these datasets is that they only contain deaths of insured patients that occurred during hospitalization. Deaths that occurred outside of hospital following discharge are not recorded in these databases. As some DRGs patients could have died after being discharge from hospitals, this limitation could lead to an over-estimation of patients’ survival time. To deal with this issue, an external control group of patients matching in conditions and severity to patients in the DRGs-group will be selected from the fee-for-services hospitals. This will allow survival time following
treatment to be treated as being \textit{independent} from the specific hospital where the patient received treatment. In other words, the probability of death following hospital discharge is assumed to be the same between the DRGs-payment hospitals and the control hospitals.

\textbf{Pilot study}

The pilot study will generate four types of data that will inform the final design of the main study.

(1) A systematic review of documents relating to the DRGs payment reform in Beijing over the past three years. Findings will be used to inform the Interview Protocol of the Key Informants interviews and refine research hypotheses;

(2) Interview data with two Key Informants from the government sector. The interviews will be used to refine the interview protocol for government informants before it is being implemented in the main study;

(3) Interview data with two Key Informants from hospital management and two clinicians. The interviews will be used to refine the interview protocol for hospital informants before it is being implemented in the main study; and

(4) Refinement of the statistical modeling approach for the quantitative component of the project based on a subset of hospital discharge data from DRG payment hospitals. Preliminary analysis of the discharge data will be conducted based on the DRG payment cases and internal control group.
9. Flowchart for the study

A systematic review of reform-related documents and relevant theories and empirical methods

Pilot study

Draft interview plans and interview protocol

Select one DRGs payment hospitals for the pilot study

Interview two informants from the government sector

Interview 2 hospital management and 2 clinicians

Collect two-year discharge data and conduct preliminary analysis

Refine Interview Protocol

Refine the statistical approach

Main study

Collect and review policy documents in the 6 DRG payment hospitals

Select control hospitals. Collect 2009-2011 hospital records data from the 6 DRGs & 6 control hospitals

Key informants interviews

Analysis of baseline hospital data

Government sectors: Reform implementation barriers and measures for overcoming them

Hospital management: Policy and behavioral responses to the reform at the level of hospital and clinical departments.

Clinicians: Understanding how incentives to them change and effect on their income, in turn to treatment pattern

Monitor the process of DRG payment implementation

Collect 2012-2014 quantitative data and the monitor information about the quality of discharge data in Beijing

Learn about the barriers encountered in the implementation of the reform from the perspectives of the government, health insurance and the DRGs hospitals, and their respective approaches for dealing with them

Measure changes in medical expenditure, length of stay, doctor’s treatment behaviors and gaming behaviors as well as healthcare quality following the introduction of the DRGs payment.

Evaluate the impact of DRGs payment on patient’s financial risks, healthcare quality, health insurance fund, hospital internal management and provider behaviors

Draw policy conclusions and provide evidence for informing ways of improving DRG-payment design and implementation in Beijing. Use the Beijing case study to inform provider payment reform elsewhere in China and other LMICs

Figure 2. Flowchart of the proposed study
### 10. Project Tasks, Timeline and Milestones (separate page(s))

<table>
<thead>
<tr>
<th>Task /Milestone</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4</td>
<td>5 6 7 8</td>
<td>9 10 11</td>
</tr>
<tr>
<td><strong>PILOT STUDY</strong></td>
<td></td>
<td></td>
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<tr>
<td>Collect and review the important literatures</td>
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<tr>
<td>Collect a sample quantitative data</td>
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<td></td>
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<tr>
<td>Preliminary quantitative analysis</td>
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<tr>
<td>Draft interview outlines</td>
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<tr>
<td>Interview two of informants</td>
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<tr>
<td>Adjust the interview plan and quantitative analysis method</td>
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<td></td>
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<tr>
<td>Prepare and submit report on pilot to CMB</td>
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<tr>
<td><strong>MAIN STUDY</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Review relevant policy documents systematically</td>
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<td></td>
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<tr>
<td>Interview informants from government sectors about the preparation of the DRGs payment reform</td>
<td></td>
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<td></td>
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<tr>
<td>Collect 2009-2011 quantitative data</td>
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<td></td>
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<tr>
<td>Analyze baseline quantitative data</td>
<td></td>
<td></td>
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<tr>
<td>Interview informants from DRGs payment hospital about the hospital internal responses to the reform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview informants from government sectors about the progress of DRGs payment implementation</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Collect discharge data from the 6 DRGs payment hospital and 6 control hospitals 2012-2014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task /Milestone</td>
<td>YEAR 1</td>
<td>YEAR 2</td>
<td>YEAR 3</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
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<tr>
<td>Data analysis (<em>DinD</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview informants from the 6 DRGs payment hospitals on the progress of the reform implementation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare academic papers and policy briefs</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Prepare and submit final Report to CMB</td>
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</tbody>
</table>
11. Feasibility of the project

Dr Weiyan Jian (PI), researcher in health policy and management at the School of Public Health at Peking University Health Sciences Center, will devote 60% time to the project. Jian will be in charge of project design, organizing and training members of the research team to collect the policy and hospital discharge data, oversee the key informant interviews, and lead the writing of the research reports and academic manuscripts. Jian has 9 years of research experience in provider payment and healthcare system evaluation, been PI on 9 research studies in this (including 3 studies as PI funded by the CMB) and 21 related peer-reviewed papers (including 5 in international journals). He is well connected with the reformers within the central and Beijing local Government, as well as management of public hospitals all over Beijing, and is in an ideal position to successfully access hospital data (as per previous projects) and key informants and lead this study.

Professor Winnie Yip (Co-PI; Professor of Health Policy and Economics at Oxford University and Peking University Health Sciences Center) – a leading international health economist with over 50 international peer-reviewed papers relating to China’s health reform – will guide the design and implementation of the proposed project. Yip will devote 7% of her time on the project providing her expert advice on the design of the project and the quantitative analysis of the hospital discharge data, and contributing to the writing of academic manuscripts and project reports. Kit-Yee Chan (Co-PI), is a Senior Research Fellow at the Nossal Institute for Global Health at the University of Melbourne and a Visiting Scholar at the Peking University Health Sciences Center, specializes in qualitative and mixed methods design and policy analysis (including over 10 peer-reviewed publications on research methods and 10 relating to health policy). Chan will devote 15% of time in the proposed project to oversee the design of the qualitative component of the project, provide interview training to the project’s research assistants, oversee the analysis and publication of the qualitative data, and participate in the drafting of academic articles and project reports.

The PI and Co-PI have worked successfully in previous collaboration. Jian has been a visiting scholar at Oxford University, under the supervision of Professor Yip and sponsored by the China Medical Board in 2011-12 and they have continued to collaborate on various projects. Chan and Jian have been working together as Co-PIs for 4 years on 4 projects (including 2 CMB funded projects), and have recently coauthored a paper in one of the most widely read international journal for health policy makers (Health Affairs).
The project will also be assisted by a number of technical consultant and research assistants. 

**Mr. Ming Lu** (researcher in health informatics) will spend 35% time working on the compilation and analysis of the hospital discharge record under Jian’s supervision. Lu is a suitable candidate for this role because of his health informatics and information technology background, and experience of being the chief analyst of the Beijing DRGs Development and Utilization Project (funded by Beijing Government). Both the PI and Lu have strong ongoing collaborations with the Beijing Health Bureau and the Beijing Bureau of Human Resource and the Social Security. The PI in particular has previously collaborative research with the two Bureaus that used similar hospital data and co-authored papers in peer-reviewed journals. The team’s well-established relationships with these government departments will ensure successful access to the discharge data and claim data required for the proposed project.

The compilation of the hospital discharge data will also benefited by the expertise of **Ms Xian Li** (Director of Patients Record Center at the Beijing Red Cross Hospital), who will spend 15% time as a consultant on the coding of discharge data. Li is the Former Director of Department of Patient Record and Statistics at the Beijing Jishuitan Hospital (2003-2009) and an external consultant of Beijing Public Health Information Center, and had been a crucial participant in developing the Beijing Clinical Modification of ICD-10 and 9.

**Ms Shunv Tang** (Research Assistant with experience working on Beijing’s health reform with Jian in other projects) will devote 35% time in data collection and analysis, and take part in the qualitative analysis and writing of project reports. **Dr Zheng Xie**, Medical Sociologist at the Peking University Health Sciences Center with expertise on hospital management system on doctor-patient relationship, will devote 15% time overseeing the day-to-day operation of the qualitative component of the project and participate in the analysis of the qualitative data. As a team, the PI and Co-PIs have a strong track record in health policy and system research (including health insurance and healthcare facilities research) and quantitative and qualitative research methods.

The team has published widely in on health reform and health policy within and outside of China. Locally, the team is well connected to the relevant government sectors and public hospitals in Beijing, and is in an ideal position to access discharge data and key informants for the study as well as transferring knowledge gained from the study to the relevant stakeholders to inform the future of the reform through well-participated workshops and briefs. The team’s international
experience also allows the project to be informed by the most recent knowledge with regards to payment reforms internationally. This international experience will also help ensure position the research findings to be disseminated to a wider international audience through publication in high impact international journal and conferences, allowing lessons of the Beijing reform to be drawn by other LMICs.

12. Monitoring and Evaluation

Monitoring of research process

The project will be monitored and evaluated against the timeline outlined in Section 10. An interim report will be written at the second quartile of year 2 at the completion of the baseline analysis and submitted to CMB. In this report, research progress will be evaluated against the project objectives and the timeline specified above. Decisions will be made on whether any changes to the research plan are needed. The final report will be written at the forth quartile of year 3.

A review panel will be set up to provide an additional mechanism for monitoring project progress. The panel will be made up of nine external reviewers who are experts in health policy, health payment reform and health insurance and relevant government sectors, and are not otherwise connected to the project. The panel will be asked to review the project briefs: (1) at the completion of the pilot study; (2) at the interim point of the project; and (3) towards the completion of the main study. A half-day workshop will be organized a week following the circulation of research briefs. During the workshop, the panel will be ask to evaluate the research progress against the project timeline, goals and objectives, and provide feedback on the research direction, approach and results of the study.

Quality control procedures

The quantitative component of the project will draw upon two databases:

(i) Discharge data administered by the Beijing Public Health Information Center (BPHIC) – This database has built-in mechanisms to check for the completeness and logic errors in the data. To further control data quality, we will randomly select 100 discharge cases from the 6 DRGs hospitals and 100 from the 6 control hospitals, and verify these data against those archived in the electronic records archived of the hospitals.

(ii) Detailed Medical Expenditure (DME) (that is, claims data) database administered by the
Beijing Health Insurance Center – We will firstly link the information contained in this database with the discharge information contained in the BPHIC database. We will then compare the total expenditure of each of the discharge record in the two databases, and assess the validity of the detail expenditure information.

For the qualitative component of the project, a detailed interview guide will be developed by the PI and Co-PI the Key Informant interviews. Research assistants will be given detailed training regarding the interview protocol on issues of inform consent, interview and recording skills. Whenever possible, interviews will be taped recorded, and fully transcribed to maximize accuracy of record. When consent for audio recording is not granted by a Key Informant, detailed notes will be taken by the interviewer during the interview and checked for error at the completion of the interview. Interview transcripts and notes will be stored electronically and processed using NVivo. In the analysis phase of the project, interview data will be triangulated against information provided by different interviewees and content of the policy documents collected during the project.

Procedures to ensure compliance with ethical standards

Prior to the commencement of data collection, ethics approval will be sought from the Human Research Ethics Committee at Peking University Health Sciences Center. Data collection will strictly adhere to the standard required by the committee – signatory to the Declaration of Helsinki 1964.

Great care will be taken to ensure the confidentiality and anonymity of participants. For the quantitative component of the project, only disaggregated hospital discharge data will be obtained from the participating hospitals. For the qualitative component, informed consent will be sought from the individual Key Informant prior to the commencement of the interviews. For interviews within hospitals, informed consent will be sought at the level of institution (hospitals), clinical departments (represented by Head of Departments), and the individual clinicians. Only disaggregated data will be used in the publications resulting from this project. In the rare cases where anonymity cannot be assured because of the position of the informant (e.g. key figures in the DRGs-payment reform), interviewees will be carefully briefed about the risks of their limited anonymity prior to the commencement of the interview, and given the opportunity to withdraw from the project. Key Informant will also be given the opportunity to review their own interview transcripts and correct for any information.
In consistent with the policy of the All data will be securely stored and password protected, accessible only to the research team. In accordance with the Human Research Ethics Committee at PUHSC all data will be kept for 5 years following the completion of the project and then destroyed.

13. Expected Outcomes and Applications

This study uses a holistic approach to monitor the progress of Beijing’s current DRGs payment reform that is designed to contain medical expenditure within Beijing’s general hospitals without compromising health care quality. The implications of the findings however go beyond the level of the Beijing municipality. Rapid growths in medical expenditure is an issue facing all regions of China and most countries worldwide, the problem is more pressing in poorer regions of China and low- and middle-income countries (LMICs) where resources are limited. Many regions of the world (including different regions within China) have been implementing different reforms to address this issue. Beijing, being China’s capital, is in the forefront of the nation’s health system reform, lessons learned from the Beijing experience will bear important relevance to other regions of China that are currently undergoing or in the process of planning payment reforms as well as nationally. In addition, the reform provides a valuable case study of DRGs-payment as a method of health expenditure containment, and could hold relevance to neighboring LMICs. The project has several feedback mechanisms for disseminating the project results local, regionally, nationally and internationally. They are:

(1) The interim and final report for the CMB summarizing the project results will be turned into policy briefs targeted at the relevant government departments responsible for the payment reform within the Beijing Municipal Government and National Government, hospital management and other interested stakeholders. The interim and final results of the briefs will be disseminated to the relevant stakeholders the mid-point and towards the second half of the final year of the project, and serve as the basis of further discussions about the reform.

(2) A One-day Knowledge Transferred National Workshop will be held in the 4th quartile of the final year of the project to bring together stakeholders from relevant government departments at the municipal and national levels and hospitals. The discussion will use the final policy briefs circulated before the workshop to focus the discussion on the policy and practical implications of the research results, and ways forward for the reform. Stakeholder feedback will be
summarized and integrated into the final report to the CMB. The project will also invite the participation of a limited number of stakeholders from government departments and hospital in other regions of China that could benefit from understanding the DRGs implementation experience in Beijing.

(3) A more detailed version of the final report will also be made available to stakeholders locally and nationally at the conclusion of the project.

(4) Peer-reviewed publications documenting the key findings of the project will be used to disseminate the project results to stakeholders within and outside of China. Open access journals will be targeted for manuscript submission as a way of reaching the widest possible audience locally and internationally (e.g. reformists in other countries and NGOs) who do not have easy access to university libraries.

(5) Presentations in national, regional and international conferences on health system reform to publicize the research findings. The conferences will also be use as a forum for the research team to link up with academics and other stakeholders nationally and internationally to learn about the experiences of reform in other health systems and generate new ideas about ways of moving forward with the Beijing reform.

14. Budget (in SUS)

<table>
<thead>
<tr>
<th>Budget Category</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Total</th>
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</thead>
<tbody>
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<td>3,000</td>
<td>3,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Equipment</td>
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<tr>
<td>Operating Expenses:</td>
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<tr>
<td>• Office Supplies</td>
<td>5,000</td>
<td>3,000</td>
<td>3,000</td>
<td>11,000</td>
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<tr>
<td>Travel:</td>
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<tr>
<td>• Domestic</td>
<td>2,000</td>
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<td>• Foreign</td>
<td>7,000</td>
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<td>9,400</td>
<td>9,400</td>
<td>28,200</td>
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<td>Evaluations</td>
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<td>1,500</td>
<td>1,500</td>
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<tr>
<td>Publications/Dissemination</td>
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<td>4,000</td>
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<tr>
<td>Administrative Cost</td>
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<td>3,267</td>
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</tr>
<tr>
<td>Grand Total</td>
<td>31,000</td>
<td>32,667</td>
<td>38,222</td>
<td>101,889</td>
</tr>
</tbody>
</table>
Narrative explanation of budgetary items

- **Personnel cost** is the remuneration for three research team members (‘participants?): Lu and Tang (35% time at the junior research assistant rate of $250/month each), and Xie (15% time at the senior researcher rate $500/month). The PI and Co-PIs of the project are all university funded staff members and will not be deducting salaries from the grant.

- **Operation expenses** include mainly the purchase of office supplies, photocopying, and the printing of research briefs and reports.

- **Domestic travel** covers transportation costs ($20/day/person) of the PI and the three ‘participants’ (average 25/person/year) to and from the hospitals and government departments to conduct the fieldwork and incidentals during the fieldwork.

- **International travel** covers the travel costs for Dr. Chan (Co-PI) to: (1) help set up the project and study protocol in the beginning of year 1 and provide the necessary qualitative data collection training for the project research assistants; (2) discuss the results of the pilot study, refine the study protocol and plan for the main study in month 6th of the project; (3) plan for data analysis and discuss the project interim results during year 2; and (4) finalize the project with the PI and contribute to the data analysis and publications towards the end of year 3. The travel is cost at $2,000 per returned economy class plane tickets from Melbourne (Australia), and $1500 for 10 days of accommodation and incidental costs (including meals, transportation, and travel insurance). Prof-Yip will not require an international travel budget, as she is a part-time professor at the PUHSC and travels to Beijing regularly.

- **Consultancy payment** covers the payment of Li (‘participant’ 4; $1,000/year over 3 years) and 5 consultants ($100/day/person, 12 days/year/consultant over 3 years) to review the inpatient records against the disease and treatment coding to provide quality control for our dataset. The 5 consultants will include 3 medical doctors whose roles will be to review the diagnoses in the patient records, and 2 health informatics consultants with expertise in diagnostic and procedural coding. This line budget will also cover the cost for hiring short-term help from each of the 12 hospitals to organize and coordinate the data quality control study and interviews with hospital management and clinicians ($200/hospital/year over 3 years).
Conferences/Workshop covers the expenses for (1) presenting project results in two international conferences (results dissemination at a regional and global level; $5000/conference); and (2) the organization of a one-day national workshop (cost at $5,000) at the end of the project that bring together stakeholders from relevant government departments at the municipal, inter-provincial and national levels and hospitals to discuss the policy and practical implications of the research results and ways forward for the reform. The Workshop expenses cover the costs of renting the conference venue, local transportation, food and refreshments for workshop participants. Conference expenses cover the returned economy class tickets from Beijing to the place of the conference ($2,000/conference), conference registration ($1,500/conference), and accommodation meals and incidentals ($1,500).

Evaluation covers the costs of three external reviews of the project involving a panel of 9 reviewers comprised of experts in health system reform and health insurance and government who are not involved with the studies. The panel will be asked to review the project briefs at the completion of the pilot study, at the interim point of the project, and towards the completion of the main study, and provide feedback on the research direction, approach and results of the study during a half-day workshop. This line item will cover the cost of the hiring of the venue, food and refreshment during the workshop, and the reviewers’ time for the evaluation (cost at $120/person/review).

Publication/Dissemination covers (1) the publication processing charges for four papers that feature some of the key findings of the research in Chinese domestic peer review journal ($200 per paper); and (2) the publication processing charges for two papers that feature the key findings of the research in international open access journal ($1,600 per paper). The choice of publishing project findings in open accessed journals is base on the fact that policy makers and other non-academic stakeholders are some of the most influential audience in this area of research. Lessons from the Beijing experience also bear relevance to health care payment reform internationally (especially to other low and middle income countries). Many of these readers do not have easy access to university libraries that subscribe to paid academic journals. Publishing in open access journals would therefore allow the project results to be disseminated to a much wider audience from both within and outside of China.
• **Administrative cost:** The regulations of Peking University Health Science Center dictate that a 10 percent overhead must be budgeted into any grant.

**15. Miscellaneous**

None.

**16. References**


[21] Beijing Health Insurance Center. Reducing the out-of-pocket payment by implementing case
based payment for the insured patients with cataract, glaucoma, hernia and thighbone and cervical bone fraction [cited 2012 Jul. 24]. Available from: 
http://www bjld gov cn/LDJAPP/search/searchdetail jsp?no=10854

[22] Beijing Health Insurance Center. The protocol of case based compensation for resection of nodular goiter [cited 2012 Jul. 20]. Available from: 
http://www bjld gov cn/LDJAPP/search/searchdetail jsp?no=14190

[23] Beijing Health Insurance Center. The protocol of case based compensation for the procedures for inguinal or femoral hernia [cited 2012 Jul. 20]. Available from: 
http://www bjld gov cn/LDJAPP/search/searchdetail jsp?no=15774


17. Concise CV of PI and Co-PIs