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A Methodological Toolkit to Reform Payment Systems: An Example of Applied Cost-Benefit Analysis

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Abstract

In principle, a careful evaluation of costs and benefits should be a wise rule for everyone who has to take any important decision. In particular, it is very important when a payment system reform is at stake. Since many stakeholders are involved in a payment system reform, the final decisions are going to be the result of several cost-benefit analyses and of "negotiation" among economic agents, in particular system providers, system participants, and end users. In this paper we will only focus on cost-benefit analysis, providing both theoretical guidelines and numerical examples. We conclude that past evaluations of payment system reforms mainly focused on qualitative assessments, hence overlooking quantitative ones. So, we suggest that it would be worthy for international institutions to spend some efforts to build, manage and make available to all countries a database on payments systems, with both relevant data and methods to assess costs and benefits.

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1 Introduction

In principle, a careful evaluation of costs and benefits should be a wise rule for everyone who has to take any important decision. In particular, it is very important when a payment system reform is at stake. A cost-benefit analysis might be

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beneficial when dealing with many relevant issues: what options to choose for the short and for the long term, how to implement the selected options, what is the optimal timing, and so on.
Since many stakeholders are involved in a payment system reform, the final decisions are going to be the result of several cost-benefit analyses and of "negotiation" among economic agents, in particular system providers, system participants, and end users. In this paper we will only focus on cost-benefit analysis (for a complete and simple introduction to cost-benefit analysis see [3], [4], [17] and [19]), since we dealt with "negotiation" in another recently published article (see [5]).
All guidelines concerning payment systems explicitly refer to cost-benefit analysis as an indispensable tool for all agents, and in particular for central banks:

- Core Principle VIII (see [7), states that, for systematically important payment systems, "the system should provide a means of making payments which is practical for its users and efficient for the economy".
- Recommendation 15 (see [8]) says that "while maintaining safe and secure operations, securities settlement systems should be cost effective in meeting the requirement of users".
- Public Policy Goal C for retail payments (see [9]) states that "policies relating to the efficiency and safety of retail payments should be designed, where appropriate, to support the development of effective standards and infrastructure arrangements".

In Section 2 we provide a primer in cost-benefit analysis with a focus on how such tool could be applied to problems concerning any payment system reform. Section 3 provides an example of a cost-benefit analysis of a payment system reform, and Section 4 concludes.

2 A Primer in Cost-Benefit Analysis (CBA)

CBA can be thought of as a procedure made of the following steps:

- Assessing the decisions to be evaluated.
- Identifying players and their utility function.
- Assessing Payoffs.
- Prioritizing.

Notice that although such steps are generally valid and should guide any decision maker, they are particularly relevant for Central Banks and the National Payment Councils (if they exist), both of which must take into account the final effect of their policies on all relevant economic agents.
In the following subsections we will discuss in detail each step.

2.1 Assessing the Decisions to Be Evaluated

Such step is a pre-condition for a correct cost-benefit analysis. To assess the decision to be evaluated, problem structuring is the best tool.

Problem structuring is the basic toolkit for consultants. It allows decision makers to analyze in depth what are the issues at stake (the so called "issue identification") and what decision have to be taken ("decision structuring").

Issue identification consists not only in decomposing a problem into issues, but also in associating several sub-issues to any issue previously identified. An example of issue identification in a payment system context is the National Payment Council strategic analysis of a country payment system (see Table 1). From Table 1, it clearly emerges how each sub-issue in our example should also be decomposed in other sub-sub-issues[4].

Table 1: National Payment Council - Issue identification

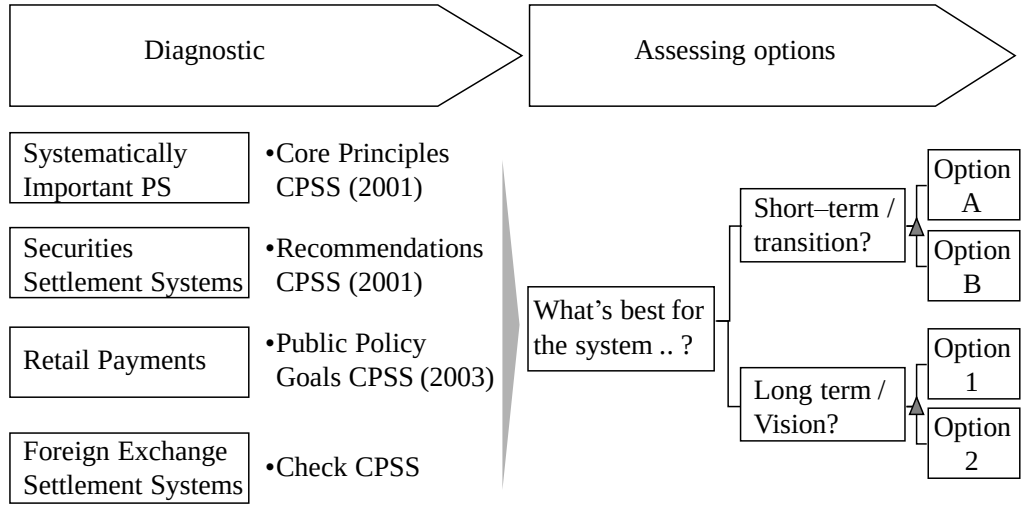
Issue	Sub-Issue
• What do we want?	• Which objectives / Principles / Targets?
• What do we have?	• Which Infrastructures / Procedures / Legal situation? • What organization / Role of the Central Bank/ Stakeholders involved?
• What could we have?	• Which are the available options? • What timing / Costs / Difficulty of implementation?
• What should we have?	• How do we rank options? How do we prioritize? What's the social welfare utility function?
• How should we get to that?	• What organization / Role of the Central Bank / Stakeholders to be involved? • What funding? • How do we manage the transition?

Once issues are identified, decision structuring allows to identify the key decisions to be made (and evaluated), looking at the hierarchical order of such decisions. Some decisions are made irrelevant if other decisions (hierarchically antecedent) are taken. As an example, a person who decides to work as an employee and not to be self-employed does not have in turn to decide whether to be on her own or to work in partnership with other people, a decision that, if self-employed, she must take.

[4] On such topic also see the methodology for stocktaking used in the context of the Western Hemisphere Payments and Securities Clearance and Settlement Initiative.

An example of decision structuring in a payment system context is described by the decision tree of a National Payment Council (see Table 2) which, once made a diagnostic of the current status of the national payment system, must decide among several options, for both the short term / the transition phase, and the long term. Notice that such decisions involve both different typology of payments (retail, securities, ..) and many other issues (how integrated the system should be, what standards of safety, ..).

Table 2: National Payment Council - Decision structuring



2.2 Identifying Players and Utility Functions

Once the decisions to be evaluated are known, CBA starts with the identification of all involved stakeholders (so called "players") and their utility functions. Typically, in a payment system reform, the set of stakeholders involved is very large (see [4]). Moreover, same stakeholders do not play the same roles in different countries; however, in the following list we classify stakeholders according to the main role that they most often play in payment systems, especially in industrialized countries:

- Central Bank, Securities and Exchange Commission, Banking Supervision, National Payment Council, Antitrust Authorities: overseers[5] of the system/ players / transactions;
- Ministries of Finance, Legislative Authorities: regulators;
- Clearinghouses, other payment service providers, the Stock Exchange, Central Security Depository: system providers;
- Commercial banks, non-bank financial institutions, brokers/dealers: mostly system participants;

[5] Oversight, banks' supervision, market surveillance.

- The Public Sector, e.g. Treasury: end user of the National Payment System;
- Consumers and firms: end-users[6].

For each player, a utility (or objective) function has to be identified by defining the relevant arguments (i.e., what affects the utility of players), and the shape of such function (i.e., which arguments are more relevant in relative terms). Typically:

- Central Banks care mostly about safety and efficiency of payments systems as a whole (see also [2], [7], [12]). Notice that while efficiency evaluations are about expected outcomes, safety considerations imply second-order considerations, that is (stochastic) considerations about standard deviation of outcomes.
- Other public institutions also care about safety and efficiency, though dedicated Authorities are focused on specific public issues (for example, antitrust authorities are obviously focused on antitrust, others on crime prevention or consumer protection, and so on). Securities commissions focus on the development of capital markets (which could potentially conflict with safety, if development implies more trading and less risk control).
- System providers - both public and private - care also about safety, overall efficiency, and own profitability. Obviously, private system providers care about own profitability more than public ones.
- Financial institutions focus on profits (efficiency). However, large banks are aware of their "public role" of maintaining the orderly functioning of the payment system, and therefore care about safety as well.
- The public sector cares about overall efficiency and safety, though balancing any automation with existing bureaucracy (and, therefore, existing safety standards) and political stability (since automation can result in job losses and, therefore, political instability).
- As for end users, firms typically care about profits, while consumers are mainly concerned about leisure and consumption. Hence, they care about safety of their transactions.

Notice that in a payment system reform two relevant issues for both safety and efficiency are the following:

- Timing. It is relevant both for the transition period (how long is it going to last?) and for the long term (for how long are the benefits going to last?).
- Difficulty of implementation, again relevant both for the transition and for the long term.

[6] Bankers' Associations are potential stakeholders, too. They represent bankers' interests toward public institutions, and mediate conflicts among banks.

To evaluate the last two issues, stochastic considerations can be appropriate, implying evaluations of standard deviations of outcomes.
Finding the shape of utility / objective functions of involved stakeholders poses several interesting theoretical problems, among which how to relatively weigh the identified arguments: for public stakeholders, for example central banks, the problem of weighting arises even when only efficiency is considered, since households' savings, firms', system participants' and system providers' profits might be differently weighted.
To derive relative weights, several techniques can be used:

- Surveying relevant stakeholders over the weight they would themselves apply;
- Running focus groups to compare different combinations of arguments (for example grouping central bank officers);
- Estimating weights by means of econometric procedures based on past observations (see [3]).

2.3 Assessing Payoffs

This step can be split into two sub-steps:

- Assessing costs and benefits (see Section 2.3.1.).
- Aggregating values over time (see Section 2.3.2.).

2.3.1 Assessing Costs and Benefits

Costs and benefits of players must be measured according to the arguments included in their utility functions. As an example, measuring costs and benefits of a project for central banks implies estimating not only final outcomes (that is, efficiency), but also the volatility of such outcomes (that is, safety).
Arguments need to be assessed in terms of actual costs and revenues of stakeholders. So, arguments need to be decomposed into unit prices and quantities of inputs and outputs. Both unit prices and quantities can be either endogenous (strategy or shadow values) or exogenous (given parameters), as it will be clarified in Section 2.4 and 3 below.
As for prices, if markets are competitive (or market imperfections are negligible), market or rental prices of inputs / outputs should be used. Otherwise, shadow pricing is the most appropriate technique; in particular, when goods are traded (on international markets), world prices can be used; when goods are non-traded, prices can be obtained through:

- Surveying consumers;
- Cross-country or cross-industry benchmarking;
- Solving agents' utility maximization problems (see [4]).

As for quantities of inputs and outputs, either it is possible to detect them from benchmarking (for example, to access the new payment system each participant needs a certain number of stations and workers each month) or they come as an outcome of some utility maximization problem.

Besides prices and quantities, other factors play a crucial role in assessing costs and benefits of a payment systems reform; in particular:

- The assessment over the stochastic distribution of outcomes - as mentioned above - plays a central role in estimating the risks of any payment system (for a Central Bank the evaluation of the systemic risk is especially important). Such assessment can be done through either an estimation (for which data are needed), or through benchmarking.
- The externality effect of having a national infrastructure for payments when trading volumes are low (especially in small economies). In order to evaluate externalities, a careful identification of all relevant parameters must be done through estimation (for which data are needed) or benchmarking.

As for the latter point, the three main parameters to take into consideration in a payment systems reform are the following:

- Quantity of transactions: a low quantity of transactions usually makes system providers and / or participants unprofitable. There is a critical mass of transactions (see [11]) that makes a payment system effective and profitable for both system participants and system providers.
- Price of transactions to participants: together with the quantity of transactions and the cost structure of system providers, it defines the business value of the payment system for the system provider.
- Price of transactions to end-users: given the previous parameters, it defines the number of profitable sustainable participants, given their costs (personnel, G&A, ..).

2.3.2 Aggregating Values over Time

In adding up values over time the choice of both a proper discount rate and an appropriate aggregating technique deserves special attention.

Discount Rate

The discount rate is the rate through which future outcomes are compared with current ones. It is the relative price of tomorrow's consumption versus today's. It can be thought of as an opportunity cost for savers and investors: in fact, investors willing to undertake an investment take into consideration the opportunity cost of forgoing alternative investments; at the same time, savers decide the amount of savings on the basis of the opportunity cost of consuming tomorrow instead of today. If markets are imperfect, investors and savers have different discount rates; moreover, private discount rates do not include the effects of current investments on future cohorts, hence differing from the social discount rate.

As for payment systems, private agents (system providers, participants, and all consumers and firms) should adopt the Capital Asset Pricing Model (CAPM) to

measure the discount rate if they act as investors. Such discount rate is defined by the following formula:

$$\delta_{CAPM} = R_F + \beta\,(R_M - R_F)$$

where R_F is the risk free rate, R_M the market return, and β the systematic risk of equities.

Central banks, instead, should act as social planners, taking into account social effects. The Social Time Preference Rate (STPR) is defined by the following formula:

$$\delta_{STPR} = r + \mu * g$$

where r is the pure rate of time preference, g is the expected growth rate of per capita consumption, and μ is the negative elasticity of marginal utility with respect to consumption.

The social discount rate weighs δ_{CAPM} and δ_{STPR} according to the nature of the payment system project: if the system induces negligible social externalities, a discount rate closer to δ_{CAPM} is more appropriate; if the system causes a high social impact, a discount rate closer to δ_{STPR} should be chosen. Notice that δ_{STPR} is usually lower than δ_{CAPM}. A reasonable rule of thumb is to set a lower bound to the social discount rate at the risk free rate.

Both discount rates induce computational difficulties, especially in countries where data are hard to retrieve. In the following list, we provide simple advices on how to compute discount rates in case data are lacking:

- R_F: if such rate is not available in the selected country, make use of the interest rate on government debt, traded on foreign markets;
- R_M and β: if no countrywide benchmarking is available, use S&P 500 as a benchmark;
- r: use low values (from 0% to 5%) to acknowledge that government cares about future generations;
- g: historically it might turn out to be negative; in such case use own estimates (even if judgemental);
- μ: micro data are needed to estimate it; if data are not available, try appropriate benchmarks.

Aggregating Technique

Net Present Value (NPV) is the most commonly used aggregating technique. It implies adding all future streams of costs and benefits, discounted at a proper discount rate δ.

NPV computations are very sensitive to changes of the discount rate, whose evaluation is therefore crucial: the lower δ, the higher the NPV. If projects should

be ranked only on the basis of their NPV, only projects with positive NPV should be undertaken, and among these, the higher the NPV, the better.
Another way of ranking projects is to compute the internal rate of return of the project (IRR), or the rate of return (δ^*), that makes the NPV equal to 0, and to compare it with the actual discount rate δ. If $\delta < \delta^*$, the project can be undertaken. The main problem with such ranking criterion is that there is room for multiplicity of δ^*.
Firms usually evaluate projects only in terms of their money value, making use of the Discounted Cash Flow (DCF) concept, which is nothing else than an NPV, where in each period cash balance is the value to be discounted.

2.4 Prioritization

Given the previous steps, the full scenario should be clear at this point (decisions, players, utility functions, payoffs); therefore, the analytical setup of the prioritization problem is straightforward.
Players have to pick the best strategy amongst all available ones in order to maximize their objective / utility functions under a set of constraints, either monetary or else (timing, politics, etc.). The prioritization problem can range from trivial (choose project A or B) to cumbersome, as shown in the example of Section 3 below.
The solution of each player's maximization problem is a partial equilibrium outcome of the cost-benefit analysis.
When more agents are involved, it is more realistic to assume that each player's strategy affects other players' payoffs: if such an assumption holds, a game must be setup, and a solution to the game has to be found through game theoretical analysis, an approach that goes beyond the scope of this paper (see [5]).

3 Example[7]

In our *ad hoc* economy, there is only one very simple national payment system (the current NPS), where the following players interact:

- A Central Bank, which operates as the overseer, the regulator, the investor (that is, it provides funds to build up the payment system), and the unique system provider. We assume that it bears only costs related to system provision.
- The Financial Institutions, which are the system participants. We assume that there are 50 participants. To simplify things, there is no Antitrust Authority, and they collude on the fees they set to consumers.

[7] The example does not refer to any country in particular.

- The Consumers, which are the only end-users. We assume there are 10 millions consumers.

If a technological shock occurs. a decision should be taken on whether to upgrade the whole NPS or not. If the NPS is upgraded, all participants must adopt the new technology when the Big Bang occurs: an upgrade implies a technological investment both for the system provider and for the system participants; moreover, a new fee system has to be implemented (i.e., new fees to participants and end-users). Hence, each agent must assess its own convenience to upgrade to the new NPS; in particular, this is a crucial decision for the Central Bank, that in many cases acts as a social planner.

We assume that both the system participants and the system provider run their operations bearing both (semi) fixed (personnel, G&A, other) and variable costs, that depend on the number of transactions intermediated. Fees are proportional: they depend on the yearly number of transactions, that are assumed to be 120 per capita.

As said, the upgrade requires relevant setup costs both for the system provider and for each participant. If setup costs are sustained at year *t*, the Big Bang is assumed to happen in *t+3*.

The effects of the upgrade are assumed to be the following:

- For consumers, each transaction will require 1 minute of time instead of 5 minutes (as in the current system).
- Fixed costs for participants will be halved, while they will be reduced by 25% for the system provider.
- Variable costs for the system provider will be halved.
- Investments required for the upgrade are € 1.5 millions for each system participant and € 20 millions for the system provider.
- The upgrade is assumed not to affect safety of the NPS.

Also, we assume that the upgrade has no effects (or negligible ones) on both the velocity of circulation of money and on the overall level consumption. This is to make our results as robust as possible in case the upgrade is found to be convenient.

Starting from the above assumptions, we can apply the methodology described in Section 2 as follows:

1. Decisions to be taken: for the Central Bank and the participants, the key problem is to choose whether to upgrade the system or not.
2. Players and Utility functions:
   - The Central Bank social welfare function is a weighted average of the utility functions of consumers and participants. Moreover, the Central Bank is constrained to keep a nonnegative DCF.
   - Utility functions of financial institutions (that is, system participants) coincide with their DCF.
   - Utility functions of consumers have two arguments: leisure and consumption.

3. Payoffs: given cost and revenue functions, it is possible to derive costs and benefits for all participants, given any fee system of the new NPS.
4. Prioritization:
   - Central Bank:
     - It has to pick a fee system for the upgraded NPS in order to maximize its own utility function. Optimal outcome must be such that aggregate utility of consumers is increased over current NPS and DCF of participants is nonnegative.
     - In Figure 1 we provide a utility possibility frontier (UPF) for the Central Bank: on the axes, the overall increase of utility with respect to the current NPS for both consumers (ΔU_C) and participants (ΔU_P) are represented. The origin of the axes is the locus where both participants and consumers are indifferent with respect to the current NPS.
     - Each point on the UPF is associated with a fee system (a pair of values of fees charged to participants and to end-users). For any fee system, the DCF for the system provider (i.e., the Central Bank) is zero.
     - Given the indifference curves of the Central Bank, the optimal fee system is the one leading to point A on the UPF, as shown in Figure 1. On point A the increase of DCF of system participants (that is, financial institutions) is close to zero.
     - The main outcomes are:[8]
       a) The system must be upgraded.
       b) Fees to participants and consumers are reduced by 43% and 18% respectively.
       c) While transactions per consumer increase by 12%, total costs per consumer decrease by 7%, and total time spent is reduced by 77%.

[8] It is assumed that system participants will join the upgrade even if they are indifferent. Calculations are straightforward, but they can be asked to authors anytime.

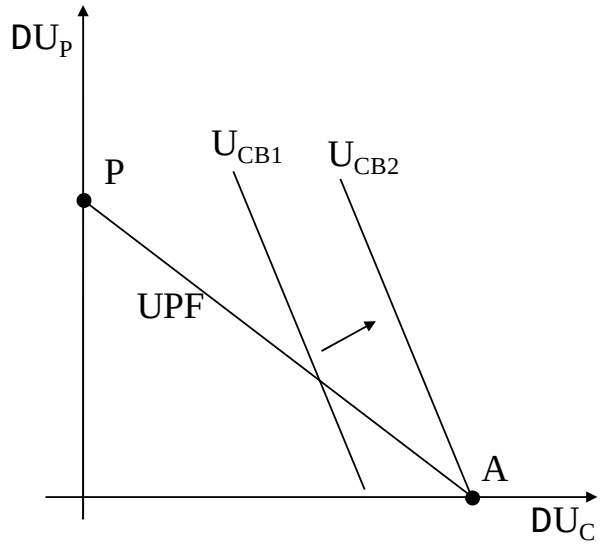


Figure 1: Maximization of system provider's utility

- Participants:
  - Their problem is to set fees to charge to end-users in the new NPS, in order to maximize their DCF (given the fees charged by the system provider).
  - Participants would pick point P on the UPF of Figure 1, being constrained not to decrease utility of consumers.

Notice that the outcomes described above differ one from the other. To find an equilibrium for the system a game should be setup (see [5]).

4 Final Comments

To run an analysis such as the one presented in the above example, the following general problems might arise:

- Tractability:
  - Problem: the complexity of the issue might be such that a formal representation cannot be performed accurately in a reasonable amount of time, or given a time constraint.
  - Advice: keep the problem as simple as possible, using an 80/20 approach (solve 80% of the problem by treating the 20% most important issues).
- Data availability:

- Problem: data are not always available, especially in less developed countries, or at least not in a reasonable amount of time or given a time constraint.
- When some issues cannot be numerically estimated:
    a) Make judgemental evaluations using qualitative assessments (for example a scale of three levels: bad, good, very good);
    b) Give numerical values to the qualitative assessments;
    c) Weigh the assessments using revealed preferences or through judgemental considerations.

By following the above advices, a useful CBA for payments systems reforms can always be run, to prioritize among options. The operators that could use it more profitably are either the National Payment Council or the Central Bank. The situations where they could apply CBA are so many, starting from the example in Section 3, that it would be hard to quote one in particular.
Even by looking at the approaches used in the past to evaluate payment system reforms - looking carefully at all qualitative elements, but perhaps not considering in depth any numerical assessment -it seems that it would be worthy for the international institutions to spend some efforts to build, manage and make available to all countries a database on payments systems, with both relevant data throughout the world and methods of assessing costs and benefits.

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