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# Evaluating changes in women's attitudes towards cervical screening following a screening promotion campaign and a free vaccination program

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**Abstract**

This study examines behavioural changes brought about by two interventions introduced to lower the incidence of cervical cancer in Australia. The first intervention is a media campaign promoting regular screening behaviour to women. The second intervention is a vaccination program providing a free HPV vaccine, Gardasil, to young women launched in the same period. The results using data from discrete choice experiments find that in general, given individual characteristics, the interventions have minor impact on how women value screening attributes. The interventions however alter women's inherent taste for screening. Unexpectedly, willingness to screen is generally lower post-interventions. The reason for this trend appears to be related to HPV events. For instance, the reduction in screening participation is particularly marked among young women who are eligible for the vaccination program. There is also a larger aversion towards testing among women who gained information on HPV facts and HPV-related measures. Thus, in the face of HPV innovations, screening promotions need to account for these factors. A simulation exercise is then performed to assess the plausibility of several strategies to increase the screening rate. The results nominate supply-side policies, in particular those targeted to health providers, as the most effective strategy.

## Introduction

Cervical cancer is one of the most preventable forms of cancer, yet it remains the second most common women's cancer worldwide (Parkin, 2005). In Australia, about 735 women are diagnosed with the cancer every year, and it is predicted that 1 in 150 women will develop the cancer by the age of 75. These numbers would be substantially lower if all women engaged in preventive behaviours. For instance, cytology tests are available to detect pre-cancerous lesions, and under Medicare, the standard Pap test is free to Australian women. It is estimated that through regular screening, 90 percent of cervical cancer cases can be prevented. Despite this fact however, there is evidence that Australian women are under-screened (Fernbach, 2001). Lack of awareness about cervical cancer and screening programs, and misunderstandings about the eligibility to these programs are among the leading reasons for this trend, suggesting that raising awareness is a necessary step towards successful cervical cancer prevention (Belkar et al. 2006; Mullins et al., 2008; Fernbach, 2001).

The most recent awareness campaign at a national level in Australia was launched in 2007. The campaign was led by a television advertisement aired through national networks prompting women to make a screening appointment if their last Pap test was more than two years ago. The graphics of the advertisement had a broad appeal (as opposed to a targeted campaign to a specific group) and did not feature a model woman's age or ethnicity. The experiences of previous health-oriented campaigns in general suggest that televised messages are a powerful means of influencing the behaviour of their audiences (Mullins et al., 2008; Dobbinson et al., 2008; White et al., 2003).

In April 2007, the Australian government also began a vaccination program. Australia is among the first countries worldwide to launch such a program at a national scale. Scientific research has led to the invention of a vaccine that could prevent 70 percent of cervical cancer cases. Unlike other forms of cancer, the cause of cervical cancer is known: infection by the Human Papilloma virus (HPV) (Franco et al., 1999). Immunity to HPV therefore avoids the pre-cancer stage all together. The vaccination program provides Gardasil, a HPV vaccine, free to females aged 12 – 26 years old as it is most effective when received prior to sexual debut. The public was informed about the availability of the vaccine through

articles, banners, posters and pamphlets, but it was not aired through television, like the screening promotion campaign.

The aim of this study is to examine women's screening preferences in response to these interventions: the screening promotion and the vaccination program. The approach taken extends policy evaluation study to include analysis of the effects of the interventions on the screening determinants. Specifically, discrete choice experiments (DCEs), a form of stated preference (SP) technique, are used to elicit women's screening preferences as well as their valuations of various screening factors. SP data have become increasingly popular in health economic studies, providing behavioural data which are not available from revealed preference (RP) data sources (e.g., market survey) (Fiebig et al., 2009; Salkeld et al., 2000; Lancsar et al., 2007; Scott and Vick, 1998; Hall et al., 2002; Ryan et al., 2006). By analysing the effects of the interventions on the screening determinants, in addition to their impact on choices, policymakers can make informed use of these factors to reshape screening behaviour in the future. The identification of the effects of the interventions will be achieved through comparisons of outcomes of the 'treated' and 'control' groups, in the standard sense that only the former was exposed to any intervention. The availability of an identical DCE conducted in 2004, before both interventions were introduced (DCE1), provides one control group. In addition, several other control groups are formed through spatial variations and randomisation in the follow-up DCE collected after both interventions (DCE2). These extra comparison groups are useful to isolate out any common (time) trend effect.

The existing literature predicts that awareness would increase women's willingness to be screeneed (Fernbach, 2001; Marcus and Crane, 1998; Jenkins et al., 1999; Mullins et al., 2000). A previous screening promotion campaign in New South Wales, for instance, recorded a 30 percent increase in screening uptake within 4 months of the promotion campaign (Shelley et al., 1991). However, never before has a screening promotion campaign been joined with a vaccination program, another means to prevent cervical cancer. These two interventions may support one another, but the vaccination program may also counteract the screening campaign's effectiveness, for example due to misconceptions that vaccination can substitute for screening (Newall et al. 2007; Kulasingam and Myers, 2003). This study will provide the first results on these issues.

## Background

Cervical cancer is a cancer of the cervix. The cancer develops when women are infected with high-risk strains of HPV (13-18 strains) for a number of years. Cigarette smoking, alcohol consumption, having multiple partners, and Human Immunodeficiency virus (HIV) infection are all associated with the development of the cancer.

As the progression of the cancer to an invasive state is slow (up to 10 years) and pre-invasive stages are largely asymptomatic, regular screening is crucial. Early detection of abnormal cells is known to have high curative rates. In Australia, the current recommendation states that women should begin screening between the age of 18 and 21, or a year after commencing sexual activity, whichever is later, and may stop at the age of 70. The recommended interval between tests for asymptomatic women is 2 years. In 1988, the government set up a committee to manage all aspects of the cervical screening process, which is currently called the National Cervical Screening Program (NCSP). One of the features of the NCSP is a reminder system to maintain women's participation in the screening program and follow-up of women with detected abnormalities.

For the past 40 years, the Pap smear test has been the main means of cervical screening, but recently alternative tests have been produced. The liquid-based Pap test is more sensitive than the conventional (standard) Pap test, and is subjected to less preparation, reading and interpretation errors (e.g., due to presence of obscuring objects), which commonly cause false-negative results in the standard Pap test. Another recent technology is a HPV test to detect specifically high-risk strains of HPV. When used in conjunction with a Pap test, this test is almost 100 percent accurate. Meanwhile, a Pap test alone is typically about 50-85 percent accurate (Salmeron et al., 2003; Wright et al., 2000).

Given the causal link of HPV infection to cervical cancer, scientists have also developed a HPV vaccine to target the initial HPV infection. Gardasil is a HPV vaccine that has been clinically proven almost 100 percent effective in preventing infections from HPV strains 16 and 18, which together account for 70 percent of cervical cancer cases (and 90 percent of genital warts). Getting the vaccine does not exempt women from screening because it does

not protect against other high-risk strains of HPV or eliminate existing exposure to HPV. The vaccine is therefore most effective when received prior to sexual debut.

## Demand for prevention

The classical economic explanation for the demand for preventive measures can be traced back to Grossman's (1972) human capital model of investment in health stock. In the model, high income earners and highly educated individuals are more likely to engage in preventive behaviour than their low-income and lowly educated counterparts because they expect larger life-time pay-offs from doing so; the return for good health is increasing in both education and income. On the other hand, older individuals have less incentive to participate in preventive behaviour because the pay-off period for their investment is shorter. Using US data, Kenkel (1994) finds support for the predictions of the model with regards to income and education. Likewise, Sabates and Fienstein (2006) highlight the role of education in screening uptake using data from the UK. They argue that education increases the likelihood of uptake of preventive measures because it is positively related to the mediating factors of participation, such as awareness, health knowledge and communication with health professionals. Using continuing education as a measure of new knowledge, they find that knowledge increases uptake of cervical screening. Meanwhile, older women are not less likely to screen compared to younger women (Rodvall et al., 2005).

Other determinants of screening uptake are environmental factors, especially knowledge. There has been evidence that the general public is ill-informed about cervical cancer (Klug et al., 2005; Marshall et al., 2007). Without awareness, women would not be able to make informed decisions. Marshall et al. (2007) conduct a survey involving some 2,000 adults to find that only 30 percent knew some factors related to cervical cancer, and just 2 percent correctly recognised 'persistent HPV infection' as its leading cause. Fylan (1998) finds that non-participation in screening can be explained by lack of awareness of screening benefits and misunderstanding of what information Pap test results provide. Many women wrongly believe that the purpose of screening is to review existing cancer stages, thereby discouraging those who consider themselves clear of the cancer from being screened. On the other hand, when the information barrier is lifted, experimental study has found that

women who previously had limited knowledge of preventative care were participating in screening (Jenkins et al., 1999).

Screening decisions are also influenced by preferences and motives. Fear of cancer for instance, has been found to be among the reasons why women avoid screening (Fylan, 1998; Cullen et al., 2004; Skrabanek, 1985). On the other hand, motivation and beliefs about susceptibility of contracting the cancer (e.g., due to family history) tend to encourage participation in screening (Mullahy, 1999).

In addition to these demand-side factors, screening participation may also be supply-driven or induced by government policies. For instance, in some countries, such as Australia and the UK, the government provides monetary incentives to health providers for screening a large number of eligible women. Myers et al. (2008), indeed argue that the bulk of the observed screening rate in the UK is due to opportunistic screening, in which the screening is initiated by the health providers.

## Discrete Choice Experiments

A novelty of this study is the use of DCEs in a policy evaluation context. A DCE is one stated-preference (SP) method of producing behavioural data that asks its respondents (subjects) for their preferred choice, as opposed to observing their actual decisions in real market situations (which fits a type of revealed-preference (RP) data). The behavioural foundation of SP methods is Lancastrian consumer theory (Lancaster, 1966), which proposes a decomposition of utility derived from the consumption of a product into the utilities derived from its attributes. Hence, in a DCE, the product of interest is described by its attributes and their associated levels (possible cases of an attribute), which jointly set a scenario. Studies have found that although stated choices are made in a hypothetical setting, in which there is no real consequence of making the choice, one goes through a similar decision making process as in the real market setting (Louviere et al., 2000).

The DCEs in this study contain the screening determinants and test options. The first DCE (DCE1) was developed by Fiebig et al. (2009) in 2004 (pre-interventions) to quantify the role of these screening factors in women's screening decisions. The contents of the DCE were guided by extensive reviews of the literature on cervical screening decisions and pilot

surveys. The study finds that both GP's characteristics and recommendations are highly influential on women's screening choices. Participation is more likely if the GP is female and/or is the regular GP seen by women for other health services. Women are also found to place a particularly high value on tests that have low false positive rates (indicating abnormality when there is no abnormality). In June 2007, after both government interventions were introduced, the experiment was rerun (DCE2). The remaining of this sub-section will describe the content of the DCEs in detail.

A scenario is described by a combination of alternative-specific attributes, which reflect the characteristics of a given test, and common or context attributes, which supposedly capture the environment in which the screening decision has to be made. As the names suggest, common attributes are fixed across alternatives. There are 3 alternative-specific attributes according to whether the Pap tests are a standard Pap or a liquid-based Pap test. These are cost and accuracy, as measured by false positive (indicating abnormality when there is no abnormality present) and false negative (concluding no abnormality when abnormality is present) rates. Another set of alternative-specific attributes vary with the alternative to have the HPV test in addition to the Pap test. These attributes are cost and GP recommendation for the additional test. Except for recommendation, all alternative-specific attributes have 4 levels, giving $2 \times 4 \times 4^{3 \times 2}$ distinct combinations between them. Meanwhile, common attributes include time since last test, GP characteristics, and the national guidelines on recommended screening intervals. All together, there are 6 context attributes with 4 levels and 2 levels, giving $4^3 \times 2^3$ (512) distinct combinations between them. Table 1 summarises all the attributes and their levels.

Table 1: Attributes and levels in the DCE

| **Attributes** | **Levels** | |
|---|---|---|
| **Common** | | |
| Last cervical screening appointment | 1 year ago; 2 years ago; 3 years ago; 5 years ago | |
| The recommended screening interval | 1 year; 2 years; 3 years; 5 years | |
| Contact with GP | Regular GP seen for most care; Never seen before | |
| Sex of GP | Female; Male | |
| Recommendation of GP | No test; Standard Pap; Liquid-based Pap; Any Pap test | |
| Financial incentive to GP | No; Yes | |
| | | |
| **Alternative-specific (Pap test)** | **Standard Pap** | **Liquid-based Pap** |
| Cost of Pap test | $0; $10; $20; $30 | A+$10; A+$20; A+$30; A+$40 |
| False negative rates | 1/20; 1/15; 1/10; 1/5 | 1/100; 1/33; 1/20; 1/10 |
| False positive rates | 1/1000; 1/250; 1/150; 1/100 | 1/2000; 1/500; 1/150; 1/100 |
| | | |
| **Alternative-specific (HPV test)** | **No HPV test** | **HPV test** |
| Cost of HPV test | 0 | $50; $100; $150; $200 |
| Recommendation to additional test | 0 | No test; test |

The combination of common and alternative-specific attributes therefore produces over 16 million ($4^4 \times 2^4 \times 4^{3 \times 2}$) possible scenarios. This product is very large and administering all of them to a respondent is both impractical and would not be manageable by the respondents. In addition, some scenarios are 'dominated', in the sense that no rational individual would choose to be tested when faced with these scenarios, for example, the scenario in which the highest cost of a test appears together with the worst accuracy levels. Experimental design techniques are therefore applied to reduce the potential scenarios to a manageable fraction, while retaining the ability to identify the utility weight of each attribute independently of each other. Specifically, the survey design construction follows the *D*-optimality criterion for main effects only design described in Burgess and Street (2004a, 2004b). For a given number of attributes and levels included in the experiment, and for a given number of alternatives in a choice set, an optimal (or near-optimal) design is an efficient one, with the smallest (or with negligible difference from the smallest) variance of the parameters to be estimated. The virtue of statistical efficiency for the estimations of the utility weights later on is its precision, which is difficult to control with RP data.

Nonetheless, the optimal design theory is made under the assumption that the experiment contains only alternative-specific attributes, as stated-choice experiments generally have this feature. To incorporate common attributes, Fiebig et al. (2009) therefore propose considering the design problem as a two stage problem. In the first stage, the choice

problem is the decision to undertake screening, given the common attributes, and in the second stage, the choice problem is deciding which type of test to take.

The process leads to 512 scenarios, comprising 32 treatment combinations for the common attributes and 16 treatment combinations for the alternative-specific attributes. The scenarios are then blocked into 16 versions of 32, with each version including all 32 treatment combinations for the common attributes. A respondent is randomly allocated to one of these 16 versions. After considering a scenario, the respondents have to choose whether to have a standard Pap test (*P*) or a liquid-based Pap test (*L*), and whether to have an additional HPV test with the selected Pap test (*PH*, *LH*). The No test (*NT*) option is also available, making the alternatives exhaustive (i.e., a 'forced choice' experiment). An example of a scenario is given in Appendix A.

The surveys also collect personal information on the respondents, such as age and income. Also included in DCE2 are four additional questions regarding their awareness about the HPV vaccine and test and personal experience with any of these measures.

## Methodology

### The econometric model

Given its foundation in utility theory, the decision-making process in a DCE by a utility-maximising respondent is assumed to involve a comparison of indirect utility functions. The alternative chosen is the one attaining the highest level of utility. Thus, if

(1) $U_{isj} = V_{isj} + \varepsilon_{isj}$,

where $U_{isj}$ represents the indirect utility function of respondent $i$ in scenario $s$ for alternative $j$, $V_{isj}$ being the deterministic component of the utility and $\varepsilon_{isj}$ capturing all other factors affecting utility that are not included in $V$ (e.g., excluded attributes or unobserved consumer taste), then the respondent $i$ will choose $j$ over $l$ if:

(2) $V_{isj} + \varepsilon_{isj} > V_{isl} + \varepsilon_{isl}$, $\forall l \neq j$ ($l, j = P, L, PH, LH, NT$).

The presence of the random component $\varepsilon$ in (2) makes it a probabilistic statement. The probability that the alternative $j$ is chosen over the other possible alternatives therefore can be written as:

(3) $\Pr(V_{isj} - V_{isl} > \varepsilon_{isl} - \varepsilon_{isj} \forall l \neq j)$.

For the deterministic component, let

(4) $V_{isj} = \tilde{x}'_{isj}\tilde{\beta} + z'_i\delta$,

where $\tilde{\beta}$ and $\delta$ are vectors of parameters to be estimated, measuring the utility weights of attributes $\tilde{x}_{isj}$ on screening choice and the influence of socio-demographics $z_i$ on choice, respectively. The different levels of screening attributes are effects-coded, whilst the different categories of socio-demographic variables are represented by a set of dummy variables. Effects-coding the attributes separates out their effects from the effects of the omitted categories of the socio-demographic variables on screening choice. For each attribute, the parameter for the reference group is internalised in the parameters of the included levels, and is given by the negative of their sum (see Bech and Gyrd-Hansen, 2005 for further arguments for effects-coding).

By assuming a probability distribution for $(\varepsilon_{isl} - \varepsilon_{isj})$, we can estimate the deterministic component of the utility. The multinomial logit (MNL) model that has been the industry-standard for multiple-alternatives problems arises if we assume *iid* (identical and independently distributed) extreme value Type I distribution. MNL however is inappropriate in this case given that each respondent provided responses to several scenarios, so serial correlation across scenarios, instead of independence, is more likely. Furthermore, substitution patterns between the test alternatives are unlikely to be consistent with the independence of irrelevant alternative (IIA) assumption of MNL, which requires proportionate substitution across all pairs of alternatives. Thus, a more flexible mixed logit model (MXL) will be used. McFadden and Train (2000) have shown that MXL has the capability of approximating any random utility model.

Let us rewrite (4) so as to separate out the alternative-specific constants (ASCs) from $\tilde{x}_{isj}$ and denote the remaining vector of attributes as $x_{isj}$. The model is now:

(5) $V_{isj} = dP_{isj}\alpha_{iP} + dL_{isj}\alpha_{iL} + dPH_{isj}\alpha_{iPH} + dLH_{isj}\alpha_{iLH} + dNT_{isj}\alpha_{iNT} + x'_{isj}\beta + z'_i\delta$,

where *dP*, *dL*, *dPH*, *dLH* and *dNT* are dummy variables for standard Pap, liquid-based Pap, joint standard Pap and HPV test, joint liquid-based Pap and HPV test, and no test option,

respectively. The modification from (4) also allows for a random intercept $\alpha_{ij}$. Further, assume that

(6) $\alpha_{ij} = \alpha_j + \omega_{ij}, \qquad \omega_{ij} \sim iid(0, \Omega),$

where $\alpha_j$ represents its mean and $\omega_{ij}$ denotes a random component that represents a deviation from the mean. A significant deviation around the mean would indicate the presence of inherent (individual-specific) taste heterogeneity in the sample population. $\omega_{ij}$ would appear as a separate error component with $\varepsilon_{isj}$, resulting in a composite error term $v_{isj} = \varepsilon_{isj} + \omega_{ij}$. $v_{isj}$ thus consists of two parts, $\varepsilon_{isj}$ that is *iid* and $\omega_{ij}$ that would follow a yet-to-be specified distribution and induce heteroskedasticity and correlation over alternatives. Notice that $\omega_{ij}$ varies over respondents, but is fixed over repeated scenarios faced by a respondent, thereby inducing serial correlation across scenarios. This implies that even if $\Omega$ is specified as diagonal, $v_{isj}$ would still be correlated over alternatives. This way of introducing non *iid* errors is often called 'error component' specification.

The normal distribution is used for (6). This assumption is arbitrary, but when there is no strong *a priori* expectation with regard to the sign of the random intercepts and the length of the tail(s) of the true taste distribution, normality is plausible. The normal distribution has support on each side of zero, reflecting that there are people who tend to choose a given alternative, and there are others who tend not to prefer it. The location of the mean will suggest the prevalence of each kind of preferences. On the other hand, in circumstances where the random coefficient is specified for a variable that has a strict domain say, of only non-negative values such as cost, the normal distribution may not be appropriate.

Under the normality assumption, the choice probability in the MXL model is a mixture of logits with a multivariate normal mixing distribution. Conditional on the random parameters, the probability will follow the standard logit specification. However, as respondent's taste is unobserved, the unconditional probability is an integral of the conditional probabilities over all possible values of the random parameters, weighted by its probability density function. This problem has no closed-form solution and is approximated numerically through simulation. For respondent $i$ facing a scenario $s$ having a specific $\beta$

and $\delta$, values for $\alpha_{ij}$ are drawn from its distribution, and using these draws, the probability that the alternative $j$ is chosen is given by:

$$(7) \qquad \hat{P}_{isj} = \frac{1}{R}\sum_r \left[ \frac{\exp[x_{isj}'\beta + z_i'\delta + \alpha_j + \omega_{ij}^r]}{1 + \sum_l \exp[x_{isl}'\beta + z_i'\delta + \alpha_l + \omega_{il}^r]} \right]$$

where *j, l = P, L, PH, LH*. As only differences in utilities matter, the no test alternative is chosen as the base with an associated utility of zero. The probability that the reference case, *j = NT*, is chosen is:

$$(7') \qquad \hat{P}_{isNT} = \frac{1}{R}\sum_r \left[ \frac{1}{1 + \sum_l \exp[x_{isl}'\beta + z_i'\delta + \alpha_l + \omega_{il}^r]} \right].$$

The mean of these simulated probabilities is then taken to the objective function to be maximised by Maximum Likelihood. For sufficiently large draws (*R*), the simulated choice probabilities have been shown to be consistent estimates of the unconditional choice probabilities. Halton draws are used in the simulation instead of random draws to increase the accuracy of estimation. The random intercepts are allowed to be freely correlated with each other; implying that $\Omega$ in (6) is given by:

$$(8) \qquad \Omega = \begin{bmatrix} \sigma_{P,P} & & & \\ \sigma_{P,L} & \sigma_{L,L} & & \\ \sigma_{P,PH} & \sigma_{L,PH} & \sigma_{PH,PH} & \\ \sigma_{P,LH} & \sigma_{L,LH} & \sigma_{PH,LH} & \sigma_{LH,LH} \end{bmatrix}.$$

**Treated and control groups**

To identify the effects of the interventions on screening choice and utility weights, we need definitions of the treated group, which has been affected by the interventions, and the control group. The DCE1 respondents are a clear control group, as this survey was collected pre-interventions. However, relying on time variation has the limitation of not knowing the extent of each woman's exposure to the interventions; there is no information in the survey, for example, about women's awareness of the screening promotion advertisement. In the extreme case, all women in DCE2 are unaware of both the screening promotion materials and the vaccination program, making them fit the definition of a control group. To deal with this problem, several other definitions for the treated and control groups are proposed. There are 4 cases in total, which care summarised in Table 2.

Table 2: Comparison samples

| Case | Treated | Control |
|---|---|---|
| 1. | DCE2 | DCE1 |
| 2. | DCE2 with prior knowledge (Prior) | DCE2 without prior knowledge (No prior) |
| 3. | DCE2 without prior knowledge, informed (Informed) | DCE2 without prior knowledge, uninformed (Uninformed) |
| 4. | DCE2 with prior knowledge, informed (Prior, Informed) | DCE1 |

Essentially the other comparison samples (Cases 2–4) are split-samples of DCE2. Case 2 uses the extra questions about HPV awareness and define respondents who have ever heard of, or experienced the HPV test or vaccine prior to the experiment as treated. Meanwhile, Case 3 and 4 make use of the randomisation exercise in DCE2, which allocated respondents into two groups, but only one of the two groups was treated. The treatment was information on HPV facts and HPV-based measures (Appendix A). Outside an experimental setting, it is very difficult to have control over each woman's exposure to relevant information, as she can obtain information from various sources and at various levels. In an experimental setting, on the other hand, both the level and the content of information known to subjects are fully controlled by the experimenter. To ensure that women in the treated group have just the amount of information set by the experiment, those with prior knowledge of HPV are excluded. Finally, women who have prior knowledge of HPV and got randomly allocated into the treatment group can also form a treated sample.

The MXL model is estimated independently for treated and control samples. By doing so, we can test if samples have different scales (the overall extent of unobserved heterogeneity). In discrete choice models, the scale factor is confounded by the utility parameters. However, the identification of the scale factor is desirable, as a larger scale implies a lower variance of the unobservables, which may result from increased awareness. Furthermore, from a policy point of view, different policy strategies are appropriate if women have the same response patterns with respect to choice attributes, but one group of women is more variable in its behaviour than others, from those that are appropriate in the situation in which the underlying behavioural parameters have genuinely changed after the interventions.

## Results

### Screening choice responses

The respondents are based on random samples within New South Wales. Each experiment involves a different sample. DCE1 consists of 167 previously-screened women. As each respondent provided responses to 32 scenarios, there are 5,344 respondent-scenarios. In DCE2, there are 154 previously-screened women to make a total of 4,928 respondent-scenarios. However, 25 respondent-scenarios have to be dropped due to multiple responses in a given scenario. Compared to women in DCE1, women in DCE2 tend to be younger, more educated and have higher incomes (Appendix B1). DCE2 also consists of more foreign-born women than DCE1. Accounting for this difference in country of birth is important, as it is a good predictor of ethnicity, which has been found to be influential for screening behaviour. For instance, Belkar et al. (2006) find that Asian women in Australia are less familiar with cervical screening, and therefore are less likely to be tested.

Before proceeding further, it is worth mentioning the presence of 4 non-traders in DCE2 (none in DCE1): one woman always chose no test, another always chose a standard Pap, and the rest always chose a joint standard Pap and HPV test. Non-trading behaviour is consistent with lexicographic preferences, whereby an individual's choice is based solely on the levels of a sub-set of attributes, ignoring all other differences. This kind of preference does not have a continuous utility function representation, which was assumed in (1) (see Campbell et al., 2006 for explicit modelling of lexicographic orderings). A decision therefore has to be made as to whether to exclude them from the analysis. It was decided that only one of them should be dropped, because she is over 70 years of age and cervical screening is no longer recommended for women in this age group. The other non-traders are retained because they can be accommodated by MXL.

The distribution of responses is reported in Table 3. In all cases, the shares of women who chose no test are shown to be higher in the treated than in the control samples. This pattern is inconsistent with the prior expectation that awareness would motivate screening participation. Investigating further, this overall increase in non participation is found to be driven by young women's choices (Appendix B2). In comparison, there is no distinct pattern across income groups. This age-specific phenomenon thus hints that the drop in

participation rate is related to the parallel vaccination program, which is targeted to these young women. For instance, they may falsely believe that vaccination and screening are alternative strategies to prevent cervical cancer, and that getting vaccinated can substitute for screening. If so, the vaccination program actually counteracts some of the effect of the screening promotion campaign, rather than working together with it to achieve the common goal of cervical cancer prevention. Another factor that could lower screening participation is the reduced value of screening programs to women as the HPV vaccine eliminates HPV strains that are readily detected by Pap tests (Schiffman, 2007). Meanwhile, the share of a given test alternative is on average stable between a pair of comparison samples.

Table 3: Sample mean of choice responses

| Case No. | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| Choice/Sample | Treated | Control | Treated | Control | Treated | Control | Treated | Control |
| | DCE2 | DCE1 | Prior | No Prior | Informed | Uninformed | Prior, Informed | DCE1 |
| No test | 0.429 | 0.373 | 0.431 | 0.419 | 0.432 | 0.410 | 0.444 | 0.373 |
| Standard | 0.228 | 0.296 | 0.188 | 0.271 | 0.243 | 0.292 | 0.197 | 0.296 |
| Standard, HPV test | 0.103 | 0.095 | 0.099 | 0.108 | 0.106 | 0.110 | 0.068 | 0.095 |
| Liquid | 0.118 | 0.118 | 0.126 | 0.111 | 0.148 | 0.083 | 0.126 | 0.118 |
| Liquid, HPV test | 0.123 | 0.119 | 0.157 | 0.090 | 0.073 | 0.105 | 0.165 | 0.119 |

Preference and attribute values

The MXL models are estimated using the routine by Hole (2007) in STATA. Table 4 reports the results for Case 1. First considering the random intercepts, in the treated sample (DCE2), all the mean intercepts are negative and statistically significant, predicting that in given a scenario, the reference women in the sample (i.e., young women with low education and income, born in Australia, and who were never smokers) would tend to choose not to be tested. On the other hand, the reference women in the control sample (DCE1) may choose to have a standard Pap test. The location of each of the mean intercepts in DCE2 is further to the left from its counterpart in DCE1, suggesting results that are consistent with the raw data discussed earlier, that the joint interventions have generated negative preferences towards testing in general.[1] However, the interventions

[1] One can find the probability of getting a value less than 0 of a normally distributed random variable with mean and standard deviation equal to the MXL estimates for each alternative. For instance, for a standard

seem to reduce the extent of heterogeneity surrounding a given test alternative. The standard deviations around the means are all large and significant, but are slightly smaller in magnitude in DCE2. Moreover, these deviations are not always larger than their respective means, which is the case in DCE1. Meanwhile, both samples exhibit significant correlation in pairwise alternatives, except between *P* and *LH*. This exception is sensible, as serial correlation is personal, and women who have a taste for technology would be most likely to choose a liquid-based Pap test over the standard Pap test.

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Pap test the probability of getting a value less than 0 of a normally distributed random variable with mean 1.5 and standard deviation 2.5 is 0.73 in DCE2.

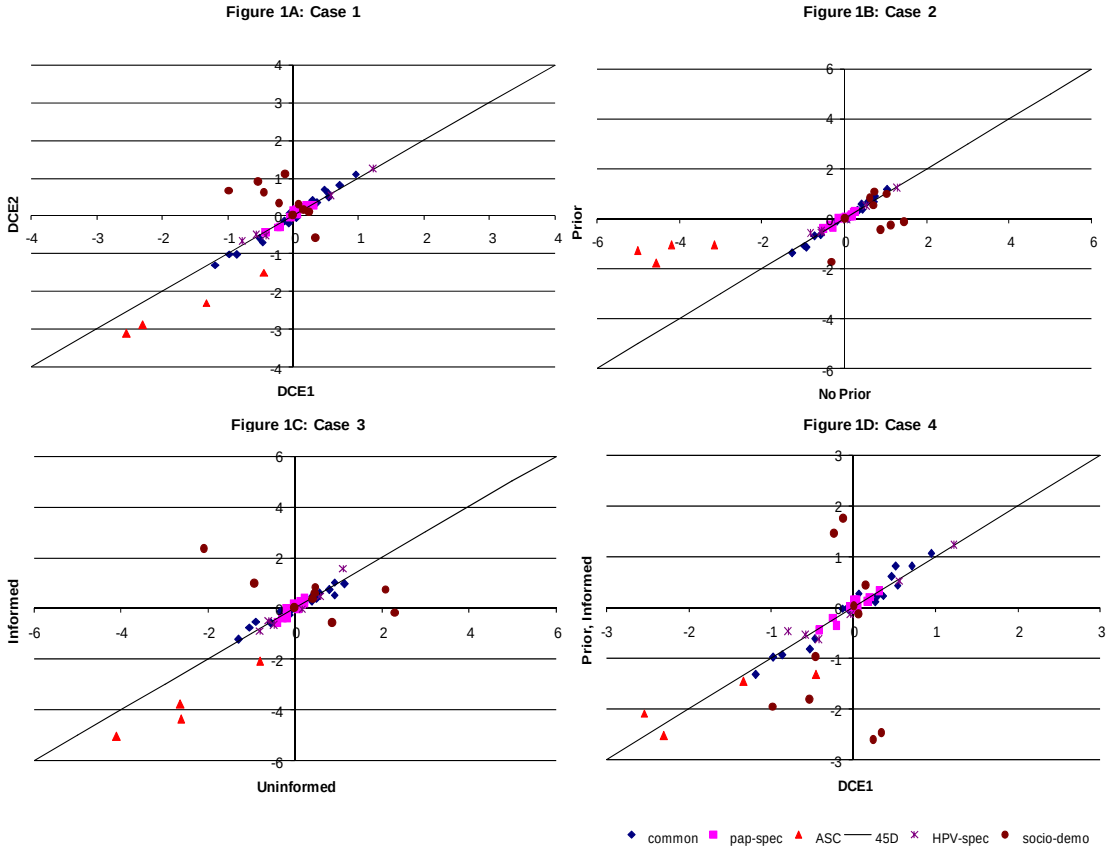
## Table 4: MXL results – Case 1

| | DCE1 | | DCE2 | | | DCE1 | | DCE2 | |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | p | Coeff. | p | | Coeff. | p | Coeff. | p |
| **Socio-demo** | | | | | **Alt-spec: Pap test** | | | | |
| Age | 0.005 | 0.620 | 0.004 | 0.693 | Cost: A+$20 | 0.318 | 0.000 | 0.268 | 0.000 |
| Trade certificates | -0.222 | 0.618 | 0.312 | 0.478 | Cost: A+$30 | 0.060 | 0.189 | 0.036 | 0.444 |
| Some uni | -0.525 | 0.173 | 0.889 | 0.139 | Cost: A+$40 | -0.418 | 0.000 | -0.449 | 0.000 |
| Completed uni | 0.160 | 0.658 | 0.139 | 0.755 | Cost: A+$10 | 0.041 | | 0.146 | |
| Inc $50- $80,000 | 0.342 | 0.343 | -0.594 | 0.183 | FP: 1/250, 1/500 | 0.021 | 0.652 | 0.113 | 0.015 |
| Inc >$80,000 | 0.243 | 0.511 | 0.085 | 0.850 | FP: 1/150, 1/150 | -0.029 | 0.524 | -0.059 | 0.208 |
| Inc missing | -0.972 | 0.036 | 0.671 | 0.586 | FP: 1/100, 1/100 | -0.205 | 0.000 | -0.321 | 0.000 |
| Not Australian-born | 0.075 | 0.853 | 0.284 | 0.425 | FP: 1/1000, 1/2000 | 0.214 | | 0.268 | |
| Current smoker | -0.452 | 0.182 | 0.598 | 0.164 | FN: 1/15, 1/33 | 0.024 | 0.590 | 0.041 | 0.379 |
| Ex-smoker | -0.114 | 0.762 | 1.094 | 0.017 | FN: 1/10, 1/20 | 0.028 | 0.533 | 0.055 | 0.239 |
| **Common** | | | | | FN: 1/5, 1/10 | -0.239 | 0.000 | -0.296 | 0.000 |
| Interval: 1 year | 0.715 | 0.000 | 0.811 | 0.000 | FN: 1/20, 1/100 | 0.186 | | 0.201 | |
| Interval: 3 years | -0.127 | 0.062 | -0.137 | 0.061 | **Alt-spec: HPV test** | | | | |
| Interval: 5 years | -0.858 | 0.000 | -1.021 | 0.000 | Rec: HPV test | 0.571 | 0.000 | 0.517 | 0.000 |
| Interval: 2 years | 0.270 | | 0.347 | | Rec: no HPV test | -0.571 | | -0.517 | |
| Last screen: 2 years | -0.061 | 0.374 | -0.205 | 0.004 | HPV cost: $100 | -0.028 | 0.719 | 0.005 | 0.955 |
| Last screen: 3 years | 0.295 | 0.000 | 0.406 | 0.000 | HPV cost: $150 | -0.411 | 0.000 | -0.540 | 0.000 |
| Last screen: 5 years | 0.951 | 0.000 | 1.102 | 0.000 | HPV cost: $200 | -0.784 | 0.000 | -0.694 | 0.000 |
| Last screen: 1 year | -1.185 | | -1.303 | | HPV cost: $50 | 1.223 | | 1.229 | |
| GP: new | -0.522 | 0.000 | -0.605 | 0.000 | **Intercepts (ASCs)** | | | | |
| GP: seen before | 0.522 | | 0.605 | | *P* | -0.445 | 0.414 | -1.500 | 0.007 |
| GP: male | -0.469 | 0.000 | -0.705 | 0.000 | Std. dev | 2.671 | 0.000 | 2.489 | 0.000 |
| GP: female | 0.469 | | 0.705 | | *L* | -1.331 | 0.014 | -2.307 | 0.000 |
| Rec: standard | 0.540 | 0.000 | 0.492 | 0.000 | Std. dev | 2.481 | 0.000 | 2.236 | 0.000 |
| Rec: liquid | 0.067 | 0.318 | 0.182 | 0.010 | *PH* | -2.299 | 0.000 | -2.898 | 0.000 |
| Rec: any Pap | 0.365 | 0.000 | 0.337 | 0.000 | Std. dev | 2.943 | 0.000 | 2.786 | 0.000 |
| Rec: no test | -0.972 | | -1.013 | | *LH* | -2.541 | 0.000 | -3.127 | 0.000 |
| GP: get finc incentive | -0.049 | 0.215 | 0.059 | 0.153 | Std. dev | 3.975 | 0.000 | 2.940 | 0.000 |
| GP: no finc incentive | 0.049 | | -0.059 | | **Correlation*** | | | | |
| | | | | | *P, L* | 0.498 | 0.000 | 0.657 | 0.000 |
| | | | | | *P, PH* | 0.507 | 0.000 | 0.504 | 0.000 |
| | | | | | *P, LH* | 0.057 | 0.115 | -0.012 | 0.844 |
| | | | | | *L, PH* | 0.558 | 0.000 | 0.387 | 0.000 |
| | | | | | *L, LH* | 0.765 | 0.000 | 0.449 | 0.000 |
| | | | | | *PH, LH* | 0.675 | 0.000 | 0.715 | 0.000 |
| | | | | | N | 26,720 | | 24,355 | |
| | | | | | Log L | -5,158 | | -4,681 | |

Note: Reported under Coeff column are MXL coefficients, and under p column is the probability value that the respective coefficient is equal to zero. Coefficients without probability values are coefficients of the reference group. 'Rec' stands for GP's recommendation. For standard Pap, the cost levels are $0, $10, $20 and $30, and the costs of liquid-based test add to these cost. For false positive (FP) and false negative (FN) rates, the first figure is for standard Pap and the second is for liquid-based test. * p-values of the covariance terms. The number of draws for the simulated probabilities is $R$ = 2,000.

Next, to compare attribute parameters from the two samples, Figure 1A plots the set of estimates from DCE2 against those obtained from DCE1. In non-linear models, this device isolates differences in scales (overall variance) from genuine differences in utility weights; estimates from different samples are not directly comparable due to confounded scales, which can be sample-specific. Scaling phenomenon implies a systematic difference between the parameter estimates from different samples, with estimates from the sample exhibiting a larger scale being scaled down. On a scatter plot of treated sample against control sample, these estimates will have a linear relationship with slope steeper than a 45-degrees line. Meanwhile, points above the45-degree line indicate larger estimates in the treated sample.

Figure 1A-D: MXL estimates comparisons




For the attributes, the plot shows that the differences in utility weights are largely systematic. While there is no obvious reason why women should change their valuations of screening attributes following the interventions, one can imagine that awareness of

screening importance reduces the weights on costs and/or increases the weights on accuracy. The results however suggest that screening participation has always been highly influenced by provider characteristics and recommendation, and costs and test accuracy received unchanging weights. Further, the statistical significances of most attribute weights are comparable in the two samples, except for the effect of time since last test. In DCE2, the reference women who are on time for screening according to the national guideline (i.e., those who had their last test within 2 years) are significantly less likely to participate in screening. The corresponding coefficient is also negative in DCE1, but is not statistically significant. This result replicates the declining trend in screening participation during the survey gap.

The different coding system for attributes and the socio-demographic variables turns out to be important, as the effects of socio-demographics, unlike the attributes' weights, vary with samples. Although most of them are not statistically significant, the reversing sign of the coefficients on education and smoking variables to positive is noteworthy. That is, in DCE2, higher education increases the propensity to test, and smokers and ex-smokers are more likely to test than non-smokers. The changing behaviour related to smoking habits in particular is a positive outcome from the perspective of women's health, as smoking increases the risk of developing cervical cancer. The coefficient on ex-smokers is statistically significant at the 5 percent level.

Figure 1B-D summarises the results from other cases. The underlying results are reported in Appendix C1-3. As in Case 1, the relationship between attributes' weights in the other comparison samples is largely one-to-one. On the other hand, inherent taste for screening and socio-demographics' effects are sample-specific; due to the dummy-coding of the socio-demographic variables, they are linked with the random intercepts.

Comparing the inherent preference for screening between women with prior knowledge of HPV (Prior sample) and those who were unaware of it (No Prior sample), the reference women in the Prior sample are found to be much less averse towards screening (Appendix C1). In Figure 1B, this result is depicted by all the mean intercepts of the tests (ASCs) located above the 45-degrees line. However among women in the No Prior sample, those who have smoking history and/or have high income and education are much more likely to

participate in screening. Meanwhile, from the comparison samples based on randomisation, women in the Informed sample tend to be more averse towards testing than those in the Uninformed sample (Appendix C2). In Figure 1C, in contrast to the earlier result, all the test intercepts lie below the 45-degrees line. A similar pattern is portrayed in Figure 1D, in comparing women in DCE1 and women in the Prior, Informed sample. These last two results are somewhat puzzling given that the treatment in the randomisation exercise was information on HPV facts. A possible explanation has to do with women's changing assessment of their susceptibility to developing the cancer. For instance, the treatment mentioned the causal link of HPV infection to cervical cancer and the fact that in most cases, the HPV infection will clear by itself. Women who had ever heard of HPV previously thought of cervical cancer as being caused by some other factors, which might have been more acute. If so, this new information may cause them to revise their risk of contracting the cancer downwards. Some women might have encountered the HPV test or vaccine, but even test participants could be unaware of HPV facts (Klug et al., 2005).

### Eligibility for free Gardasil

Whether it is the parallel vaccination program in particular that creates the aversion towards testing can be checked by removing young women (under 30 years old), who are eligible for the vaccination program, from the DCE2 sample. This restriction reduces the sample by nearly half. Re-estimating the model, the results now find that all test means are statistically indifferent from zero, suggesting that the parallel vaccination program is a part of the story (Appendix C4). Meanwhile the results regarding the screening attributes are largely consistent with those obtained from the unrestricted sample; the correlation coefficient between them is 0.98. As additional information on the test preference of older women, the restriction was also imposed on DCE1, and it was found that all test mean intercepts are negative and significant. Variations around the means are substantial in any case, but that for the joint liquid-based Pap and HPV test alternative is considerably smaller in size in the DCE2 sample.

To sum up, despite the screening promotion effort, the majority of women (still) prefer not to be screened. Spatial comparisons suggest that this is due to a reduction in the taste for screening related to HPV events. Meanwhile, the values of screening attributes to a typical woman and the overall scale, which one may interpret as measuring the extent of

uncertainty surrounding screening decision-making in general, appear to be independent of any intervention. The policy implication following these results is therefore for future screening promotion effort to integrate the HPV innovations. In particular, the relationship between cervical cancer, screening, HPV facts, and HPV-based measures must be communicated in an orderly fashion to avoid confusion and prevent women from making false self-assessments of their risk of developing the cancer. Better delivery of information may also reduce the uncertainties surrounding the screening decision.

## Policy simulations

Given the significant role of providers in women's screening decisions, stimulating their involvements seems to be a plausible strategy to boost screening rates. Using the attributes related to the GP in the experiment, simulation is used to forecast the impact of this strategy. As alternative strategies, let us consider a price reduction, which is the common policy instrument to increase demand and an investment in Research and Development (R&D) that produces a more accurate Pap test. Currently, the standard Pap test is covered by Medicare, but the newer tests would involve positive out-of-pocket costs. Meanwhile, with regards to test accuracy, the standard Pap test has a 1 percent false positive rate and a 20 percent false negative rate.

Consider the case for a representative woman who is on-time for screening (the last test occurred within 2 years). To reflect reality, attributes with real-life counterparts are specified accordingly; that is, 2 years recommended screening interval and accuracy levels as specified above. Other attributes are selected so that the predicted screening rate in DCE1 for 20-69 years olds is consistent with the actual two-year participation rate for these groups of women according to the Australian Institute of Health and Welfare's (AIHW) report, which is 58 percent in 2003-2004 (AIHW, 2008). The corresponding market share for 2007 onwards is not (yet) available. This alignment requires the GP to be specified as male and as the regular GP of the women. The HPV test costs $50, and is not recommended.

The 'price effect' ($E_1$), 'provider effect' ($E_2$) and 'R&D effect' ($E_3$) to screening participation are found as follows:

(9) $$\overline{E}_{1NT} = \frac{1}{N}\sum_{i=1}^{N}\left(\overline{P_{iNT}^{L}} - \overline{P_{iNT}^{H}}\right),$$

(10) $$\overline{E}_{2NT} = \frac{1}{N}\sum_{i=1}^{N}\left(\overline{P_{iNT}^{P}} - \overline{P_{iNT}^{NR}}\right),$$

(11) $$\overline{E}_{3NT} = \frac{1}{N}\sum_{i=1}^{N}\left(\overline{P_{iNT}^{A}} - \overline{P_{iNT}^{L}}\right),$$

where $N$ is the sample size, and $\overline{P_{iNT}}$ is the individual average of the probability of no test (*NT*) alternative from 100 draws, drawn from their estimated distributions. The parameters are given by the MXL estimates. The superscript $H$ ($L$) denotes the case in which screening was recommended without the test type specified and the liquid-based Pap test costs an additional $40 ($10), superscript $P$ ($NR$) denotes the case in which the GP recommended the standard Pap test (not recommending testing), and superscript $A$ denotes the case in which the accuracy of the standard Pap increases to a 0.1 percent false positive rate and a 5 percent false negative rate. The R&D effect is found using the probability of no test under the low price case, $\overline{P_{NT}^{L}}$, as the reference point. Within-sample variations are achieved by the random draws as well as variations in socio-demographics characteristics.

Table 5 reports the results for (9) – (11). For the extent of the policy change considered, all of the three policies have considerable effects on the screening rate. The price subsidisation can reduce the non-participation rate by around 20 percent in most samples. Meanwhile, by encouraging health providers to take a more active role in screening promotion (perhaps, in women's visits for other purposes), the non-participation rate can be reduced by 40 to 50 percent. A large provider effect is indeed not impractical (Myers et al., 2008). R&D spending on technology research has a similar-size effect to the provider effect, but arguably, the R&D returns take longer. For an immediate impact, the government therefore may consider the price strategy, although a generous subsidy (in the above case 75 percent of the costs) may be needed for large effects, and/or extending incentives for opportunistic screening (e.g., amending the current Practice Improvement Program (PIP)). For the longer run effect, resources can be allocated to R&D that improves test accuracy.

**Table 5: Simulation results on the probability of no test**

| **Sample** | N | $\overline{E_1}$ [%] | Std. Dev | $\overline{E_2}$ [%] | Std. Dev | $\overline{E_3}$ [%] | Std. Dev |
|---|---|---|---|---|---|---|---|
| DCE1 | 167 | -0.051 | 0.006 | -0.176 | 0.062 | -0.079 | 0.011 |
| | | [17.41%] | | [43.92%] | | [32.60%] | |
| DCE2 | 153 | -0.076 | 0.007 | -0.196 | 0.014 | -0.118 | 0.016 |
| | | [19.63%] | | [40.24%] | | [38.09%] | |
| 95% CI of DCE1 means | | (-0.067, -0.037) | | (-0.222, -0.135) | | (-0.112, -0.054) | |
| **DCE2 Sub-samples** | | | | | | | |
| No Prior | 77 | -0.097 | 0.014 | -0.197 | 0.023 | -0.127 | 0.030 |
| | | [23.03%] | | [38.80%] | | [39.36%] | |
| Prior | 76 | -0.068 | 0.009 | -0.223 | 0.025 | -0.126 | 0.026 |
| | | [17.29%] | | [43.15%] | | [39.06%] | |
| Uninformed | 44 | -0.074 | 0.019 | -0.170 | 0.039 | -0.106 | 0.033 |
| | | [16.65%] | | [31.69%] | | [28.62%] | |
| Informed | 33 | -0.132 | 0.034 | -0.242 | 0.054 | -0.157 | 0.062 |
| | | [31.87%] | | [47.95%] | | [55.42%] | |
| Prior, Informed | 43 | -0.074 | 0.017 | -0.181 | 0.038 | -0.100 | 0.033 |
| | | [18.09%] | | [36.92%] | | [29.86%] | |
| 95% CI of No prior means | | (-0.012, -0.055) | | (-0.234, -0.122) | | (-0.173, -0.055) | |
| 95% CI of Prior means | | (-0.085, -0.035) | | (-0.276, -0.129) | | (-0.178, -0.053) | |

Note: 95% CI denotes 95% confidence interval: $\bar{x} \pm 2\sigma_{\bar{x}}$.

It is also of interest to predict the type of test women are most likely to take, had they participated in screening. Consider the ratio

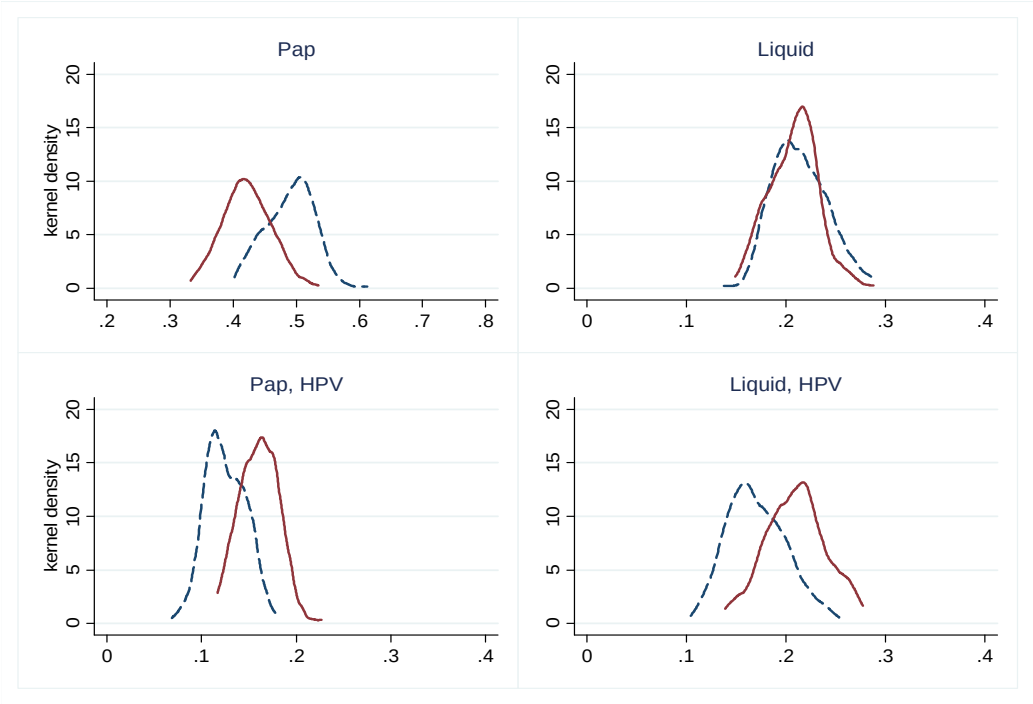
$$(12) \qquad \overline{R}_{2l} = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{\overline{P_{il}^{P}} - \overline{P_{il}^{NR}}}{\overline{P_{iNT}^{NR}} - \overline{P_{iNT}^{P}}}\right], \qquad l = P, PH, L, LH \ ,$$

which is used to indicate how women substitute away from non-participation to a test alternative following policies targeted to providers. The distributional behaviour for the other strategies will be similar, as within-sample sources of variations are not changing with strategies. (12) is a meaningful quantity in MXL, due to its flexibility in allowing for taste heterogeneity and choice dependence. In contrast, the measure would not vary over alternatives in the conditional logit model, which assumes proportional substitution.

Figure 2 plots the distribution of $\overline{R}_2$ for women in DCE1 and DCE2 samples. It is shown that about half of the increase in screening participation is reflected in the take-up of a standard Pap test in DCE1, whilst in DCE2 larger shares are translated to the take-up of a HPV test. This exercise is repeated for women in the Prior and No Prior samples, and the

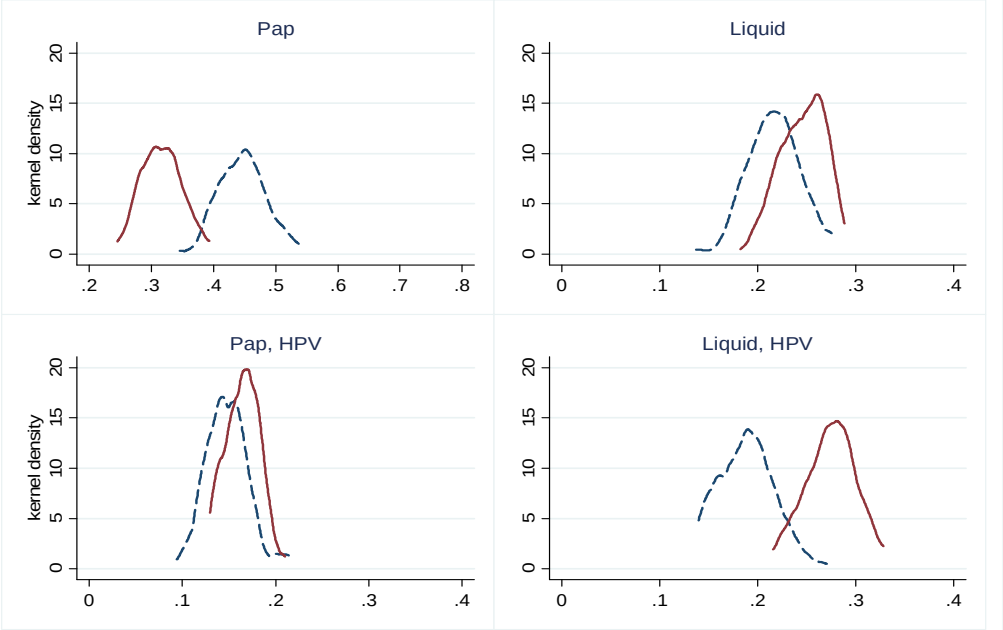
results are plotted in Figure 3. Women in the Prior sample are shown to be more likely to book for the advanced tests when participating, whilst women in the No Prior sample behave much more like women in DCE1, choosing the standard Pap test when participating. As HPV materials get recognised over time, this finding predicts a progressive departure from the conventional Pap test. As such, how to deal with the availability of the advanced tests should also be on the agenda of the policymakers.

Figure 2: Distribution of stimulus effect – Case 1




Note: each quadrant plots the kernel density (%) of a given test alternative assuming Gaussian weights. The horizontal axis is $\overline{R_2}$ for a given test. The dash (solid) line corresponds to DCE1 (DCE2) sample.

Figure 3: Distribution of stimulus effect – Case 2




Note: each quadrant plots the kernel density (%) of a given test alternative assuming Gaussian weights. The horizontal axis is $\overline{R_2}$ for a given test. The dash (solid) line corresponds to No Prior (Prior) sample.

**Model assumptions**

Before concluding, several important technical points must be mentioned. The first one is the assumption of an additive, linear utility function. Generally, the linear-in-parameters specification is assumed by discrete choice models. To increase flexibility, attributes with multiple levels have been represented by categorical variables that allow for non-linear relationships between them and utility.

The second point is the use of error component modelling. While this approach is a convenient way to accommodate non *iid* errors, it assumes that the main of source heterogeneity is inherent taste heterogeneity among women. Some variations however may be related to a particular attribute, and the error component model does not capture this source of heterogeneities. Extending the model to also allow for heterogeneous preferences may improve the fit and explanatory power of the model, but the size of the resulting model can be overwhelming, as there are quite a number of attributes to be considered as random. The main source of heterogeneity could also be scale heterogeneity, instead of inherent taste heterogeneity, or a combination of inherent taste and scale heterogeneity, in which case MXL may be inappropriate due to incorrect mixing assumptions. The application of a

more flexible model, such as the generalized multinomial logit model (GMNL) proposed by Fiebig et al. (2009) to allow for alternative sources of heterogeneities is left for future study. The persistent results that attribute parameters between comparison sample pairs are almost perfectly related however suggests that the role of scale heterogeneity (in addition to the correlated taste heterogeneity) in the conclusions about the effect of interventions is minor.

The third issue is also related to the adequacy of MXL. A way to measure the gain from estimating MXL from *iid*-based models is to compare their log-likelihood values. It is found that the improvements are quite substantial, measuring to 28 to 30 percent (22 to 28 percent) of the log-likelihood values of the conditional logit model without (with) alternative-specific constants across samples and 14 to 26 percent of the log-likelihood values of MNL. Meanwhile, in terms of predictive power, MXL produces 46 to 50 percent overall correct prediction rates, in the sense of aligning predicted and actual choices. The predicted choice is given by the alternative with the highest probability of being chosen. For the random intercepts, 100 draws are used to compute the average individual probabilities, just like in the policy simulation exercise (Section 3.6.4). Table 6 reports the number of correct predictions for each test alternative and its actual cases. It is shown that the models generally lack power in predicting the "middle" test alternatives, liquid-based Pap (*L*) and joint Pap and HPV tests (*PH*), and perform better at predicting no test (*NT*) and Pap test only (*P*) alternatives. This pattern can be explained by the domination of the latter two alternatives as well in the actual cases. The Prior sample seems to be an exception, as the number of women choosing the variant test alternatives are more spread out in this sample, but the model was able to pick up the greater preference for joint liquid-based Pap and HPV test (*LH*) among these women. It is noteworthy however that if differences in probabilities between the test alternatives are small, the correct prediction rate provides limited information.

Overall, the MXL specification selected appears to be a sensible one to use in this analysis. The key issue in identifying the intervention effect is the need to split the (DCE2) sample, making it infeasible to contemplate more flexible (complicated) models.

**Table 6: Correct prediction table**

| Sample | | *NT* | *P* | *PH* | *L* | *LH* | Total |
|---|---|---|---|---|---|---|---|
| DCE1 | Correct | 1,551 | 852 | 0 | 0 | 66 | 2,469 |
| | Actual | 1,991 | 1,582 | 506 | 631 | 634 | 5,344 |
| DCE2 | Correct | 1,714 | 491 | 18 | 3 | 64 | 2,290 |
| | Actual | 2,070 | 1,118 | 504 | 578 | 601 | 4,871 |
| No Prior | Correct | 843 | 302 | 18 | 1 | 32 | 1,196 |
| | Actual | 1,025 | 662 | 265 | 272 | 220 | 2,444 |
| Prior | Correct | 901 | 112 | 8 | 35 | 108 | 1,164 |
| | Actual | 1,045 | 456 | 239 | 306 | 381 | 2,427 |
| Uninformed | Correct | 438 | 247 | 4 | 0 | 6 | 695 |
| | Actual | 570 | 406 | 153 | 116 | 146 | 1,391 |
| Informed | Correct | 389 | 132 | 9 | 1 | 0 | 531 |
| | Actual | 455 | 256 | 112 | 156 | 74 | 1,053 |
| Prior, Informed | Correct | 539 | 80 | 0 | 15 | 54 | 688 |
| | Actual | 610 | 271 | 93 | 173 | 226 | 1,373 |

## Conclusion

This study has analysed changes in women's attitudes towards cervical screening following the latest (2007) screening promotion campaign and a parallel vaccination program providing HPV vaccine, Gardasil, in Australia. Discrete choice experiments were used to elicit women's valuations of screening attributes and their preferences for a test alternative. The successes of previous screening promotion campaigns and other preventive health campaigns (e.g., the SunSmart program) led to the expectation that the promotion campaign would substantially increase the cervical screening rate. However, it is found that the proportion of women willing to be screened is generally lower after the joint interventions. This trend is unexpected, but at least in Australia, there is no precedent for concurrently running a screening promotion campaign and a vaccination program.

The reduction in the participation rate appears to be associated with HPV events. First, the reduction in willingness-to-screen is particularly marked among young women, who can obtain Gardasil for free under the vaccination program. Meanwhile, there is little evidence that given individual characteristics, the older women are averse towards testing. These results therefore suggest that while screening and vaccination are both preventive means for cervical cancer, the effectiveness of the screening promotion effort need not be enhanced by the vaccination program. Second, women who were newly informed about HPV facts

tend to have a stronger aversion towards test alternatives than otherwise similar uninformed women. Presumably, their willingness to be screened fell as they misinterpreted HPV facts and re-adjusted their risk of developing the cancer downwards. If so, it is clear that women require clarification about the position of screening in the face of the innovations related to HPV.

Through a simulation exercise, several potential strategies to increase future screening rates were evaluated, and the result suggests that encouraging a more active role of health providers is the most effective strategy among those considered to achieve this goal, capable of reducing the non-participation rate by close to one half. Meanwhile, R&D spending on technology that improves test accuracy can be justified on the basis of its expected sizeable impact on screening participation in the longer term.

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Appendix A: Example of a scenario

**Scenario 1:**
You are visiting the GP who gives you some information about Pap tests and raises the issue of having a Pap test.

**About this GP:**

| | |
|---|---|
| This GP is | your regular GP who you usually see for most care, including Pap tests |
| This GP is | male |
| This GP's practice will receive a special incentive payment if you have a Pap test at this visit | Yes |

**About the tests available:**

| | Standard Pap test | Liquid based Pap test |
|---|---|---|
| The out of pocket costs to you for this test will be | $10 | $40 |
| The chance that this test will give you a false negative result is | 1 in 10 | 1 in 20 |
| The chance that this test will give you a false positive result is | 1 in 150 | 1 in 250 |

**Other information the GP gives you about cervical screening:**

| | |
|---|---|
| The GP tells you that you had your last Pap test | about 3 years ago |
| The national recommendation is that women should have a Pap test | every 2 years |
| If you have either Pap test, you can at the same time have an HPV test, at an additional out-of-pocket cost to you of | $50 |
| The GP recommends that | you have the standard Pap test |
| The GP recommends that you | do not have the HPV test |

**At this visit to the GP what would you choose to do?**

| | |
|---|---|
| *Circle the number next to your choice*<br>**I would not have a cervical cancer screening test** | **1** |
| **I would have a standard Pap test** | **2** |
| **I would have the liquid based Pap test** | **3** |
| *Circle Yes or No to show your choice*<br>**If you chose to have a Pap test, would you also have the HPV test at this visit?** | **Yes**<br>**No** |

**Appendix A (cont')**

The following information was given randomly to only half of the respondents in the follow-up DCE (DCE2)

***What is HPV?*** Human Papillomavirus (HPV) is a sexually transmitted infection commonly affecting both men and women. Almost all abnormal Pap smear results are caused by HPV. However, in 98% of cases, HPV infection clears by itself. In rare cases, if the virus persists and is left undetected, it can lead to cervical cancer. This usually takes about 10 years. Although there are many strains of HPV, only a few cause cancer. Strains 16 and 18 cause about 70% of all cervical cancers.

One vaccine (GARDASIL) has been approved for use in Australia. GARDASIL prevents infection from strains 16 and 18 if individuals are vaccinated before they are infected with them. It is a preventive measure and will not treat existing HPV infections. GARDASIL is given as a series of three injections over a period of seven months. The Australian Government has decided to fund GARDASIL under the National Immunization Program for girls and women aged 12-26, so this vaccine will be available free of charge for these age groups.

Commencing in 2007, girls aged 12 and 13 will be vaccinated at school. Girls who are aged 13-18 in 2007 will be vaccinated in a catch-up program. Women aged up to and including age 26 will be vaccinated in a community-based program, generally through GPs. The vaccine will be provided free but if a GP provides the vaccine, there could be a charge for the GP consultation.

Sexually active women up to and including 26 years who are vaccinated will, overall, derive less protection than when the vaccine is given before sexual activity commences. Being vaccinated **does not** mean that women will be able to stop having Pap tests because HPV vaccination does not protect against all HPV types and will not stop all cases of cervical cancer or pre-cancerous cervical lesions.

While the HPV test can give information about whether a woman has been infected by the human papilloma virus, it does not, in general give information about which particular strain of HPV is involved, so cannot help in deciding whether GARDASIL will provide protection for an individual woman. The best indicator of whether GARDASIL is likely to lower risk of cervical cancer is whether or not a woman is or has previously been sexually active.

Appendix B1: Summary statistics (percent of the sample)

| | DCE1 | DCE2 | | | | | |
|---|---|---|---|---|---|---|---|
| | | All | No Prior | Prior | Uninformed | Informed | Prior, Informed |
| **Age (sample mean)** | 41.85 | 36.12 | 35.96 | 36.29 | 36.14 | 35.72 | 38.15 |
| **Education** | | | | | | | |
| Secondary or lower | 0.54 | 0.44 | 0.51 | 0.36 | 0.50 | 0.53 | 0.42 |
| Trade certificates | 0.16 | 0.18 | 0.18 | 0.18 | 0.23 | 0.12 | 0.23 |
| Some university | 0.10 | 0.12 | 0.12 | 0.13 | 0.09 | 0.15 | 0.07 |
| Completed university | 0.20 | 0.26 | 0.19 | 0.33 | 0.18 | 0.20 | 0.28 |
| **Country of birth** | | | | | | | |
| Not Australia | 0.14 | 0.21 | 0.26 | 0.17 | 0.20 | 0.32 | 0.16 |
| **Income** | | | | | | | |
| <=$50,000 | 0.63 | 0.47 | 0.58 | 0.37 | 0.57 | 0.59 | 0.42 |
| $50,000 - $80,000 | 0.16 | 0.26 | 0.26 | 0.26 | 0.30 | 0.21 | 0.23 |
| >$80,000 | 0.14 | 0.24 | 0.15 | 0.33 | 0.11 | 0.21 | 0.30 |
| Missing | 0.07 | 0.03 | 0.01 | 0.04 | 0.02 | 0.00 | 0.05 |
| **Smoking** | | | | | | | |
| Never | 0.54 | 0.58 | 0.54 | 0.62 | 0.57 | 0.50 | 0.58 |
| Current smoker | 0.23 | 0.25 | 0.26 | 0.25 | 0.25 | 0.26 | 0.28 |
| Ex-smoker | 0.23 | 0.17 | 0.20 | 0.13 | 0.18 | 0.24 | 0.14 |
| **HPV-related** | | | | | | | |
| Heard of HPV test | | 0.32 | | 0.63 | | | 0.70 |
| Heard of HPV vaccine | | 0.39 | | 0.79 | | | 0.86 |
| Recommended to HPV test | | 0.06 | | 0.12 | | | 0.12 |
| Recommended to HPV vaccine | | 0.02 | | 0.04 | | | 0.05 |
| N | 167 | 154 | 78 | 76 | 44 | 34 | 43 |

# Appendix B2: Choice distribution by age and income groups

## 1. Choice distribution by age group

**Choice: No Test**

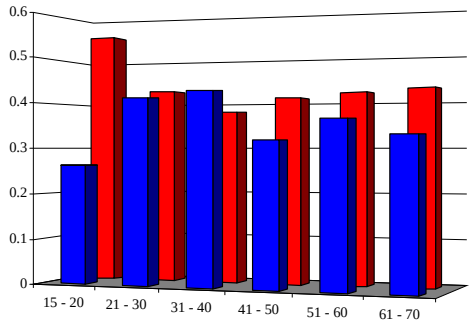



**Figure 3c: Case 3**

**Choice: Standard Pap only**

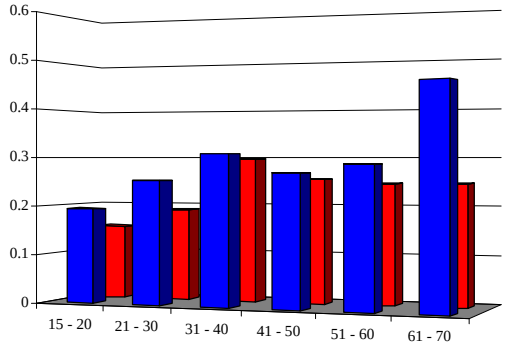
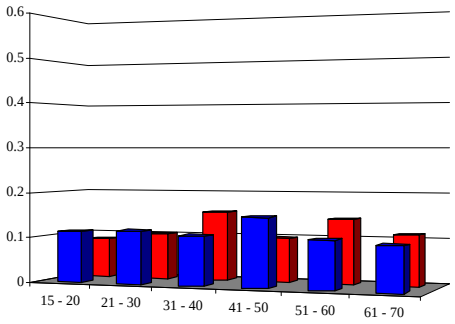
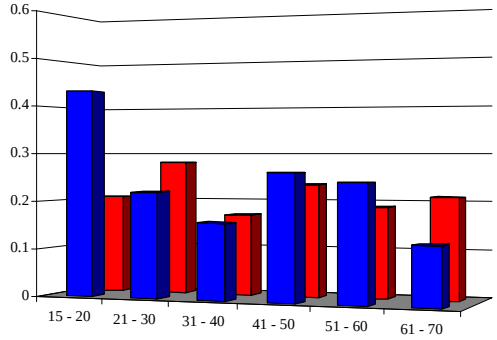



**Figure 3d: Case 4**

**Choice: Liquid-based Pap only**




**Choice: Pap test & HPV test**




Note: Each bar represents the sample mean of women in a given age group choosing the specific test option. The first row (yellow bars) is based on DCE1 sample and the second row (blue bars) represents the case for all women DCE2.

2. Choice distribution by income group

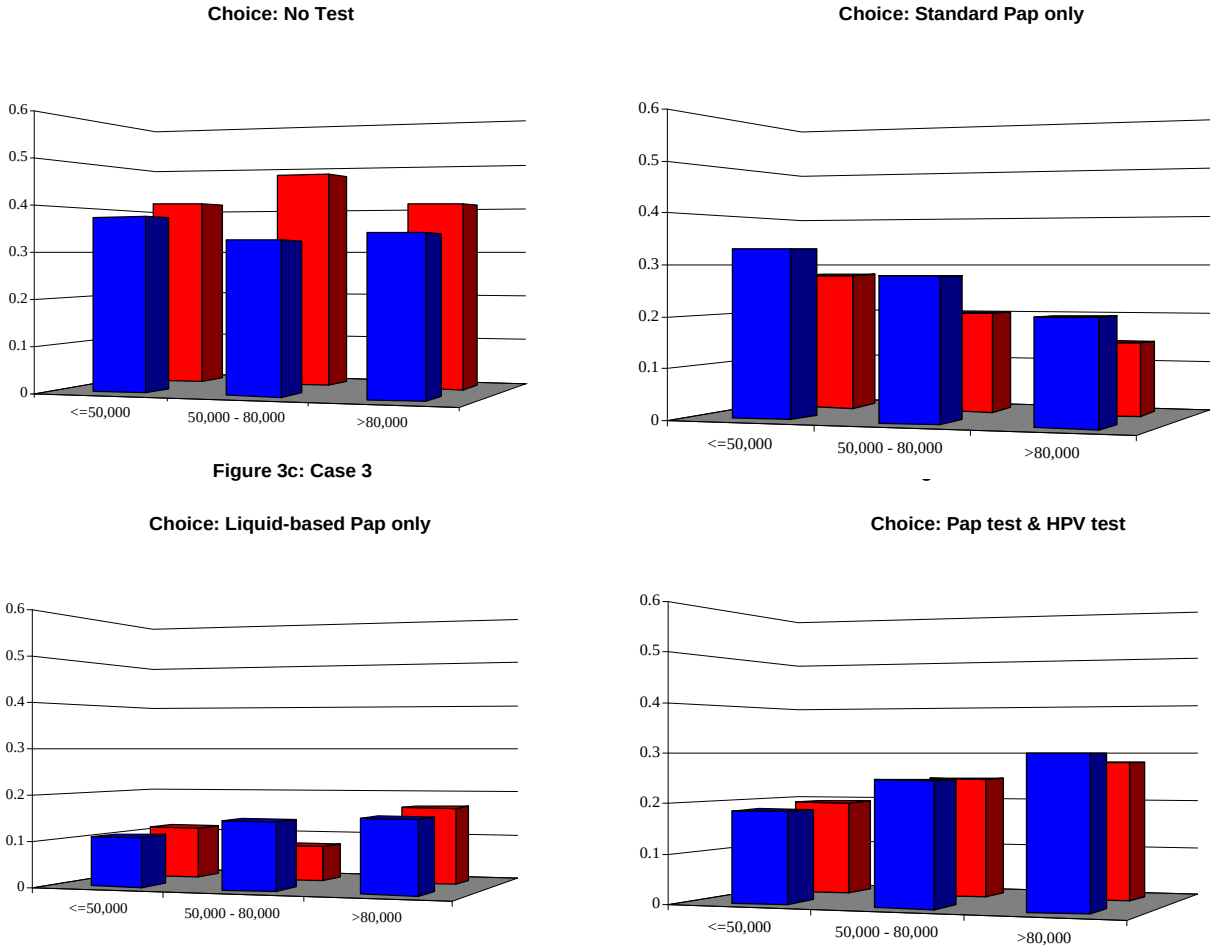



**Figure 3c: Case 3**

Note: each bar represents the sample mean of women in a given income group choosing the specific test option. The first row (yellow bars) is based on DCE1 sample and the second row (blue bars) represents the case for all women DCE2.

## Appendix C1: MXL results – Case 2

| | No prior | | Prior | | | No Prior | | Prior | |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | p | Coeff. | p | | Coeff. | p | Coeff. | p |
| **Socio-demographics** | | | | | **Alt-spec: Pap test** | | | | |
| | | | | | Cost: A+$20 | 0.282 | 0.000 | 0.253 | 0.000 |
| Age | 0.034 | 0.003 | -0.008 | 0.589 | Cost: A+$30 | 0.009 | 0.890 | 0.056 | 0.384 |
| Trade certificates | 0.752 | 0.085 | 1.101 | 0.081 | Cost: A+$40 | -0.489 | 0.000 | -0.409 | 0.000 |
| Some university | 1.056 | 0.029 | 0.999 | 0.073 | Cost: A+$10 | 0.197 | | 0.100 | |
| Completed university | 0.726 | 0.141 | 0.552 | 0.270 | FP: 1/250, 1/500 | 0.146 | 0.029 | 0.083 | 0.203 |
| Inc $50 - $80,000 [a] | -0.286 | 0.480 | -1.711 | 0.000 | FP: 1/150, 1/150 | -0.112 | 0.100 | -0.006 | 0.925 |
| Inc >$80,000[a] | 0.893 | 0.063 | -0.479 | 0.344 | FP: 1/100, 1/100 | -0.280 | 0.000 | -0.357 | 0.000 |
| Inc missing [a] | | | -0.973 | 0.349 | FP: 1/1000, 1/2000 | 0.247 | | 0.281 | |
| Not born in Australia | 0.618 | 0.107 | 0.798 | 0.122 | FN: 1/15, 1/33 | 0.053 | 0.429 | 0.029 | 0.653 |
| Current smoker | 1.471 | 0.000 | -0.164 | 0.756 | FN: 1/10, 1/20 | 0.060 | 0.367 | 0.051 | 0.430 |
| Ex-smoker | 1.145 | 0.022 | -0.300 | 0.610 | FN: 1/5, 1/10 | -0.321 | 0.000 | -0.274 | 0.000 |
| **Common** | | | | | FN: 1/20, 1/100 | 0.207 | | 0.194 | |
| Interval: 1 year | 0.752 | 0.000 | 0.879 | 0.000 | **Alt-spec: HPV test** | | | | |
| Interval: 3 years | -0.177 | 0.084 | -0.094 | 0.372 | Rec: HPV test | 0.547 | 0.000 | 0.498 | 0.000 |
| Interval: 5 years | -0.909 | 0.000 | -1.150 | 0.000 | Rec: no HPV test | -0.547 | | -0.498 | |
| Interval: 2 years | 0.334 | | 0.365 | | HPV cost: $100 | 0.080 | 0.500 | -0.058 | 0.601 |
| Last screen: 2 years | -0.234 | 0.017 | -0.173 | 0.091 | HPV cost: $150 | -0.547 | 0.000 | -0.541 | 0.000 |
| Last screen: 3 years | 0.443 | 0.000 | 0.369 | 0.000 | HPV cost: $200 | -0.821 | 0.000 | -0.596 | 0.000 |
| Last screen: 5 years | 1.047 | 0.000 | 1.166 | 0.000 | HPV cost: $50 | 1.288 | | 1.196 | |
| Last screen: 1 year | -1.255 | | -1.362 | | **Intercepts (ASCs)** | | | | |
| GP: new | -0.561 | 0.000 | -0.660 | 0.000 | *P* | -3.159 | 0.000 | -1.065 | 0.128 |
| GP: seen before | 0.561 | | 0.660 | | Std. dev | 2.023 | 0.000 | 2.434 | 0.000 |
| GP: male | -0.718 | 0.000 | -0.692 | 0.000 | *L* | -4.196 | 0.000 | -1.070 | 0.111 |
| GP: female | 0.718 | | 0.692 | | Std. dev | 1.831 | 0.000 | 2.103 | 0.000 |
| Rec: standard | 0.425 | 0.000 | 0.567 | 0.000 | *PH* | -4.549 | 0.000 | -1.781 | 0.011 |
| Rec: liquid-based | 0.190 | 0.053 | 0.177 | 0.083 | Std. dev | 3.116 | 0.000 | 2.770 | 0.000 |
| Rec: any Pap | 0.339 | 0.001 | 0.331 | 0.001 | *LH* | -5.016 | 0.000 | -1.288 | 0.056 |
| Rec: no test | -0.955 | | -1.075 | | Std. dev | 3.301 | 0.000 | 2.803 | 0.000 |
| GP: get finc incentive | 0.112 | 0.052 | 0.002 | 0.980 | **Correlation*** | | | | |
| GP: no finc incentive | -0.112 | | -0.002 | | *P, L* | 0.405 | 0.005 | 0.775 | 0.000 |
| | | | | | *P, PH* | 0.520 | 0.000 | 0.308 | 0.001 |
| | | | | | *P, LH* | -0.091 | 0.184 | 0.070 | 0.266 |
| | | | | | *L, PH* | 0.281 | 0.025 | 0.355 | 0.000 |
| | | | | | *L, LH* | 0.423 | 0.002 | 0.429 | 0.000 |
| | | | | | *PH, LH* | 0.703 | 0.000 | 0.834 | 0.000 |
| | | | | | N | 12,220 | | 12,135 | |
| | | | | | Log L | -2,314 | | -2,344 | |

Note: [a] for No prior sample, the reference group is women with income less than $50,000 and a woman with missing income information. The woman with missing income is aged 15 – 20 years old. For Prior sample, the reference group is women with income less than $50,000. Those with missing income information are classified as separate category. The number of replication for simulated probabilities are $R$=1000.* p-values of the covariance term.

## Appendix C2: MXL results – Case 3

| | Uninformed | | Informed | | | Uninformed | | Informed | |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | p | Coeff. | p | | Coeff. | p | Coeff. | p |
| **Socio-demographics** | | | | | **Alt-spec: Pap test** | | | | |
| Age | -0.001 | 0.931 | 0.013 | 0.312 | Cost: A+$20 | 0.206 | 0.023 | 0.381 | 0.000 |
| Trade certificates | 0.869 | 0.191 | -0.576 | 0.362 | Cost: A+$30 | 0.061 | 0.496 | -0.047 | 0.644 |
| Some university | -2.104 | 0.019 | 2.328 | 0.000 | Cost: A+$40 | -0.417 | 0.000 | -0.580 | 0.000 |
| Completed university | -0.918 | 0.216 | 0.975 | 0.058 | Cost: A+$10 | 0.150 | | 0.246 | |
| Inc $50 - $80,000 [a] | 0.412 | 0.421 | 0.394 | 0.382 | FP: 1/250, 1/500 | 0.157 | 0.081 | 0.135 | 0.178 |
| Inc >$80,000 [a] | 0.475 | 0.597 | 0.620 | 0.235 | FP: 1/150, 1/150 | -0.181 | 0.052 | -0.036 | 0.721 |
| Not born in Australia | 2.304 | 0.007 | -0.149 | 0.731 | FP: 1/100, 1/100 | -0.188 | 0.039 | -0.405 | 0.000 |
| Current smoker | 0.458 | 0.479 | 0.842 | 0.077 | FP: 1/1000, 1/2000 | 0.212 | | 0.306 | |
| Ex-smoker | 2.069 | 0.005 | 0.762 | 0.122 | FN: 1/15, 1/33 | 0.071 | 0.432 | 0.039 | 0.703 |
| **Common** | | | | | FN: 1/10, 1/20 | 0.001 | 0.989 | 0.127 | 0.203 |
| Interval: 1 year | 0.794 | 0.000 | 0.720 | 0.000 | FN: 1/5, 1/10 | -0.279 | 0.003 | -0.378 | 0.000 |
| Interval: 3 years | -0.133 | 0.356 | -0.251 | 0.091 | FN: 1/20, 1/100 | 0.207 | | 0.212 | |
| Interval: 5 years | -1.047 | 0.000 | -0.753 | 0.000 | **Alt-spec: HPV test** | | | | |
| Interval: 2 years | 0.386 | | 0.284 | | Rec: HPV test | 0.592 | 0.000 | 0.477 | 0.000 |
| Last screen: 2 years | -0.332 | 0.015 | -0.144 | 0.318 | Rec: no HPV test | -0.592 | | -0.477 | |
| Last screen: 3 years | 0.488 | 0.000 | 0.385 | 0.009 | HPV cost: $100 | 0.155 | 0.298 | -0.017 | 0.930 |
| Last screen: 5 years | 1.144 | 0.000 | 0.976 | 0.000 | HPV cost: $150 | -0.475 | 0.003 | -0.676 | 0.002 |
| Last screen: 1 year | -1.300 | | -1.217 | | HPV cost: $200 | -0.793 | 0.000 | -0.885 | 0.000 |
| GP: new | -0.554 | 0.000 | -0.583 | 0.000 | HPV cost: $50 | 1.113 | | 1.579 | |
| GP: seen before | 0.554 | | 0.583 | | **Intercepts (ASCs)** | | | | |
| GP: male | -0.904 | 0.000 | -0.522 | 0.000 | *P* | -0.812 | 0.373 | -2.095 | 0.004 |
| GP: female | 0.904 | | 0.522 | | Std. dev | 2.600 | 0.000 | 1.090 | 0.005 |
| Rec: standard | 0.384 | 0.005 | 0.465 | 0.001 | *L* | -2.636 | 0.004 | -3.766 | 0.000 |
| Rec: liquid-based | 0.168 | 0.217 | 0.233 | 0.105 | Std. dev | 1.988 | 0.002 | 2.101 | 0.001 |
| Rec: any Pap | 0.356 | 0.009 | 0.331 | 0.020 | *PH* | -2.630 | 0.008 | -4.373 | 0.000 |
| Rec: no test | 0.907 | | 1.030 | | Std. dev | 2.362 | 0.000 | 3.111 | 0.010 |
| GP: get finc incentive | 0.111 | 0.165 | 0.108 | 0.195 | *LH* | -4.098 | 0.000 | -5.063 | 0.000 |
| GP: no finc incentive | -0.111 | | -0.108 | | Std. dev | 2.479 | 0.000 | 2.418 | 0.020 |
| | | | | | **Correlation*** | | | | |
| | | | | | *P, L* | 0.718 | 0.008 | 0.275 | 0.080 |
| | | | | | *P, PH* | 0.438 | 0.012 | 0.222 | 0.051 |
| | | | | | *P, LH* | -0.223 | 0.037 | -0.208 | 0.129 |
| | | | | | *L, PH* | 0.405 | 0.019 | -0.140 | 0.374 |
| | | | | | *L, LH* | 0.320 | 0.024 | 0.180 | 0.545 |
| | | | | | *PH, LH* | 0.551 | 0.001 | 0.799 | 0.013 |
| | | | | | N | 6,955 | | 5,265 | |
| | | | | | Log L | -1,287 | | -988 | |

Note: [a] for Uninformed sample, the reference group is women with income less than $50,000 and a woman with missing income information. The woman with missing income is aged 15 – 20 years old. For Informed sample, all women have income information. The number of replication for simulated probabilities are $R$=1000. * p-values of the covariance term.

## Appendix C3: MXL results – Case 4

| | DCE1 | | Prior Informed | | | DCE1 | | Prior Informed | |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | p | Coeff. | p | | Coeff. | p | Coeff. | p |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Socio-demographics** | | | | | **Alt-spec: Pap test** | | | | |
| Age | 0.005 | 0.620 | 0.029 | 0.073 | Cost: A+$20 | 0.318 | 0.000 | 0.314 | 0.000 |
| Trade certificates | -0.222 | 0.618 | 1.467 | 0.011 | Cost: A+$30 | 0.060 | 0.189 | -0.002 | 0.986 |
| Some university | -0.525 | 0.173 | -1.819 | 0.071 | Cost: A+$40 | -0.418 | 0.000 | -0.450 | 0.000 |
| Completed university | 0.160 | 0.658 | 0.434 | 0.548 | Cost: A+$10 | 0.041 | | 0.138 | |
| Inc $50 - $80,000 | 0.342 | 0.343 | -2.474 | 0.000 | FP: 1/250, 1/500 | 0.021 | 0.652 | 0.141 | 0.104 |
| Inc >$80,000 | 0.243 | 0.511 | -2.610 | 0.000 | FP: 1/150, 1/150 | -0.029 | 0.524 | -0.003 | 0.974 |
| Inc missing | -0.972 | 0.036 | -1.939 | 0.193 | FP: 1/100, 1/100 | -0.205 | 0.000 | -0.356 | 0.000 |
| Not born in Australia | 0.075 | 0.853 | -0.137 | 0.878 | FP: 1/1000, 1/2000 | 0.214 | | 0.218 | |
| Current smoker | -0.452 | 0.182 | -0.970 | 0.053 | FN: 1/15, 1/33 | 0.024 | 0.590 | 0.110 | 0.205 |
| Ex-smoker | -0.114 | 0.762 | 1.753 | 0.042 | FN: 1/10, 1/20 | 0.028 | 0.533 | -0.031 | 0.728 |
| **Common** | | | | | FN: 1/5, 1/10 | -0.239 | 0.000 | -0.194 | 0.030 |
| Interval: 1 year | 0.715 | 0.000 | 0.825 | 0.000 | FN: 1/20, 1/100 | | | | |
| Interval: 3 years | -0.127 | 0.062 | -0.010 | 0.942 | **Alt-spec: HPV test** | | | | |
| Interval: 5 years | -0.858 | 0.000 | -0.924 | 0.000 | Rec: HPV test | 0.571 | 0.000 | 0.538 | 0.000 |
| Interval: 2 years | 0.270 | | 0.109 | | Rec: no HPV test | -0.571 | | -0.538 | |
| Last screen: 2 years | -0.061 | 0.374 | 0.011 | 0.935 | HPV cost: $100 | -0.028 | 0.719 | -0.119 | 0.470 |
| Last screen: 3 years | 0.295 | 0.000 | 0.235 | 0.086 | HPV cost: $150 | -0.411 | 0.000 | -0.635 | 0.000 |
| Last screen: 5 years | 0.951 | 0.000 | 1.076 | 0.000 | HPV cost: $200 | -0.784 | 0.000 | -0.473 | 0.007 |
| Last screen: 1 year | -1.185 | | -1.322 | | HPV cost: $50 | 1.223 | | 1.227 | |
| GP: new | -0.522 | 0.000 | -0.822 | 0.000 | **Intercepts (ASCs)** | | | | |
| GP: seen before | 0.522 | | 0.822 | | *P* | -0.445 | 0.414 | -1.319 | 0.058 |
| GP: male | -0.469 | 0.000 | -0.617 | 0.000 | Std. dev | 2.671 | 0.000 | 2.328 | 0.000 |
| GP: female | 0.469 | | 0.617 | | *L* | -1.331 | 0.014 | -1.450 | 0.031 |
| Rec: standard | 0.540 | 0.000 | 0.449 | 0.001 | Std. dev | 2.481 | 0.000 | 1.581 | 0.000 |
| Rec: liquid-based | 0.067 | 0.318 | 0.290 | 0.036 | *PH* | -2.299 | 0.000 | -2.522 | 0.000 |
| Rec: any Pap | 0.365 | 0.000 | 0.243 | 0.070 | Std. dev | 2.943 | 0.000 | 3.165 | 0.000 |
| Rec: no test | -0.972 | | -0.982 | | *LH* | -2.541 | 0.000 | -2.078 | 0.004 |
| GP: get finc incentive | -0.049 | 0.215 | -0.039 | 0.621 | Std. dev | 3.975 | 0.000 | 3.534 | 0.000 |
| GP: no finc incentive | 0.049 | | 0.039 | | **Correlation*** | | | | |
| | | | | | *P, L* | 0.498 | 0.000 | 0.668 | 0.001 |
| | | | | | *P, PH* | 0.507 | 0.000 | 0.375 | 0.001 |
| | | | | | *P, LH* | 0.057 | 0.115 | 0.100 | 0.172 |
| | | | | | *L, PH* | 0.558 | 0.000 | 0.396 | 0.000 |
| | | | | | *L, LH* | 0.765 | 0.000 | 0.425 | 0.000 |
| | | | | | *PH, LH* | 0.675 | 0.000 | 0.909 | 0.000 |
| | | | | | | | | | |
| | | | | | N | 26,720 | | 6,865 | |
| | | | | | Log L | -5,158 | | -1,241 | |

Note: The number of replication for simulated probabilities are $R$=1000. * p-values of the covariance term.

Appendix C4: MXL result – restricted sample of women over 30 years old

| | Restricted DCE1 | | Restricted DCE2 | | | Restricted DCE1 | | Restricted DCE2 | |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | p | Coeff. | p | | Coeff. | p | Coeff. | p |
| **Socio-demographics** | | | | | **Alt-spec: Pap test** | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | 0.034 | 0.035 | -0.040 | 0.036 | Cost: A+$20 | 0.375 | 0.000 | 0.308 | 0.000 |
| Trade certificates | 0.214 | 0.682 | 0.249 | 0.606 | Cost: A+$30 | 0.074 | 0.166 | -0.053 | 0.428 |
| Some university | 0.503 | 0.249 | 0.279 | 0.696 | Cost: A+$40 | -0.478 | 0.000 | -0.436 | 0.000 |
| Completed university | 0.599 | 0.214 | 0.425 | 0.410 | Cost: A+$10 | 0.029 | | 0.180 | |
| Inc $50 - $80,000 | 0.095 | 0.819 | -0.280 | 0.554 | FP: 1/250, 1/500 | -0.012 | 0.826 | 0.183 | 0.005 |
| Inc >$80,000 | 0.473 | 0.277 | -0.783 | 0.157 | FP: 1/150, 1/150 | -0.002 | 0.971 | -0.071 | 0.288 |
| Inc missing | -1.651 | 0.001 | 0.179 | 0.837 | FP: 1/100, 1/100 | -0.225 | 0.000 | -0.364 | 0.000 |
| Not born in Australia | -0.415 | 0.246 | 0.487 | 0.257 | FP: 1/1000, 1/2000 | 0.238 | | 0.251 | |
| Current smoker | -0.049 | 0.927 | 0.110 | 0.840 | FN: 1/15, 1/33 | 0.037 | 0.487 | 0.059 | 0.369 |
| Ex-smoker | -0.367 | 0.339 | 1.743 | 0.000 | FN: 1/10, 1/20 | 0.033 | 0.532 | 0.038 | 0.565 |
| **Common** | | | | | FN: 1/5, 1/10 | -0.247 | 0.000 | -0.293 | 0.000 |
| Interval: 1 year | 0.754 | 0.000 | 0.851 | 0.000 | FN: 1/20, 1/100 | 0.177 | | 0.196 | |
| Interval: 3 years | -0.095 | 0.234 | -0.085 | 0.417 | **Alt-spec: HPV test** | | | | |
| Interval: 5 years | -0.969 | 0.000 | -1.092 | 0.000 | Rec: HPV test | 0.527 | 0.000 | 0.537 | 0.000 |
| Interval: 2 years | 0.309 | | 0.326 | | Rec: no HPV test | -0.527 | | -0.537 | |
| Last screen: 2 years | -0.060 | 0.449 | -0.285 | 0.005 | HPV cost: $100 | -0.051 | 0.581 | -0.053 | 0.664 |
| Last screen: 3 years | 0.308 | 0.000 | 0.445 | 0.000 | HPV cost: $150 | -0.473 | 0.000 | -0.558 | 0.000 |
| Last screen: 5 years | 1.038 | 0.000 | 1.340 | 0.000 | HPV cost: $200 | -0.838 | 0.000 | -0.497 | 0.000 |
| Last screen: 1 year | -1.286 | | -1.501 | | HPV cost: $50 | 1.362 | | 1.108 | |
| GP: new | -0.568 | 0.000 | -0.702 | 0.000 | **Intercepts (ASCs)** | | | | |
| GP: seen before | 0.568 | | 0.702 | | *P* | -1.936 | 0.079 | 0.717 | 0.436 |
| GP: male | -0.414 | 0.000 | -0.734 | 0.000 | Std. dev | 2.880 | 0.000 | 3.083 | 0.000 |
| GP: female | 0.414 | | 0.734 | | *L* | -2.204 | 0.044 | 0.314 | 0.735 |
| Rec: standard | 0.505 | 0.000 | 0.436 | 0.000 | Std. dev | 2.865 | 0.000 | 2.408 | 0.000 |
| Rec: liquid-based | 0.038 | 0.633 | 0.139 | 0.173 | *PH* | -3.674 | 0.001 | -1.025 | 0.297 |
| Rec: any Pap | 0.354 | 0.000 | 0.264 | 0.009 | Std. dev | 3.030 | 0.000 | 3.389 | 0.000 |
| Rec: no test | -0.897 | | -0.838 | | *LH* | -3.143 | 0.003 | -0.859 | 0.359 |
| GP: get finc incentive | -0.070 | 0.127 | 0.046 | 0.441 | Std. dev | 5.118 | 0.000 | 3.647 | 0.000 |
| GP: no finc incentive | 0.070 | | -0.046 | | **Correlation*** | | | | |
| | | | | | *P, L* | 0.432 | 0.000 | 0.526 | 0.000 |
| | | | | | *P, PH* | 0.473 | 0.000 | 0.421 | 0.000 |
| | | | | | *P, LH* | -0.074 | 0.018 | -0.179 | 0.004 |
| | | | | | *L, PH* | 0.459 | 0.000 | 0.570 | 0.000 |
| | | | | | *L, LH* | 0.728 | 0.000 | 0.521 | 0.000 |
| | | | | | *PH, LH* | 0.598 | 0.000 | 0.732 | 0.000 |
| | | | | | | | | | |
| | | | | | N | 20,160 | | 12,940 | |
| | | | | | Log L | -3,691 | | -2,301 | |

Note: The number of replication for simulated probabilities are $R$=1000. * p-values based on covariance terms. Only 25 percent of DCE1 sample are aged less than 30. The number of women in the restricted sample is 81. Results for unrestricted case DCE2 are reported in Table 4.