Modelling the Economic and Environmental Impacts of Population Policy in Jersey: a Multi-Period Computable General Equilibrium Analysis[1]

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Abstract: This paper uses a multi-period economic-environmental CGE modelling framework to analyse the impacts of natural population change and the relaxation of migration constraints in a labour-constrained economy. Population and environmental concerns are core elements of sustainable economic development policy in the target economy of Jersey. Specifically, CGE model simulations are used to track the impact of changes in population on a number of energy-consumption and pollution indicators under alternative hypotheses regarding economic conditions over the time period under consideration. In the case of Jersey, we find that household consumption is the key factor governing the environmental impact of economic disturbances. Therefore the analysis includes an examination of the sensitivity of the simulation results to different assumptions regarding demand and production elasticities that affect the elasticity of labour demand and therefore the responsiveness of household income to shifts in labour supply.

Key words: computable general equilibrium modelling, population, environment, Jersey.

1. Introduction

Jersey is the largest of the Channel Islands that lie to the east of the French Normandy coast, about 100 km south of the English mainland. While it has been known as popular tourist destination and exporter of agricultural produce, its economy is in fact now dominated by its (largely externally-owned) Finance sector[2]. In 1998 it had a population of around 89,000 people, but population is a live policy issue on the island. On the one hand, there is concern over the potential adverse economic effects that would accompany a static or declining labour force, particularly in the face of strong demand for the primary export sector, Finance. It is feared that the resulting tightness of the labour market would stifle economic activity. On the other hand, any increase in population is expected to have adverse environmental effects through increased congestion and pollution. There is therefore a strong faction within the island that wishes to stabilise the population level at its present level.

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[2] For example, in 1998 the 3 main finance sectors, Banks & Building Societies, Investment Trusts & Fund Managers and Insurance Companies directly accounted for 17% of employment, 28% of wage income and 50% of GDP in Jersey in 1998. In contrast, the Agriculture & Fishing sector only accounted for 4.3% of employment, 2.5% of wage income and 1.3% of GDP. Tourist demand for local outputs directly accounted for 10.9% of employment, 6.1% of wage income and 5.1% of GDP. (See Fraser of Allander Institute, 2001a.)

In this paper, we wish to identify the nature of the trade-off involved in a population expansion using an economic-environmental Computable General Equilibrium (CGE) model for Jersey (JEMENVI). The model quantifies the economic and environmental impacts of alternative population and labour-force projections over a policy-relevant 10-year period. These demographic disturbances are modelled with and without an expansion in demand to the Finance sector. In the reported results, we focus on the changes occurring by the end of the period. These represent the culmination of a sequence of temporary equilibria as the economy adjusts to the sequence of demand- and supply-side shocks.

Section 2 outlines the model and its parameterisation and Section 3 gives the simulation strategy. Section 4 presents a theoretical discussion of the impacts of the demographic changes. Section 5 presents the simulation results, including some sensitivity analysis. Section 6 is a brief conclusion.

2. The JEMENVI Model

Model Structure

JEMENVI is an extension of the AMOS regional CGE model, adapted to incorporate environmental variables and parameterised on Jersey data.[3] It is paIn general, AMOS is best regarded as a modelling *framework* “because it encompasses a range of behavioural assumptions, reflected in equations which can be activated and configured in many different ways” (Harrigan *et al*, 1991, p. 424). It therefore transcends any single perspective of the operation of markets in the economy. However in this paper, due to space constraints, a very particular version of the model is presented. Specifically, we use here the period-by-period version of the model, with a very restricted labour market closure. Although the restrictions made are appropriate for the purpose at hand, the JEMENVI model is not limited to these options.

Before discussing details of the model structure, its dimensions are outlined. The model has 3 transactor groups - households, firms and government - and 2 exogenous external transactors - the UK and the rest of the world, (ROW). There are 25 activities/commodities and these are listed in Table A.1 of the Appendix. The degree of sectoral disaggregation is limited by confidentiality requirements.

Table 1 gives a condensed version of the JEMENVI model. It is simplified representation of the model where intermediate demand has been suppressed, income transfers not identified and taxes ignored. Production is assumed to take place in perfectly competitive industries, using multi-level production functions. Intermediate purchases of locally produced goods and services in the base year (long-run) equilibrium are determined by the industry-by-industry block of the IO table and are substitutable for imported commodities via an Armington link. The composite input then combines with value-added (capital and labour) in the production of each sector’s gross output.

Value-added is produced using capital and labour typically via a constant elasticity of substitution (CES) technology, so there can be input substitution in response to relative price changes, but with Leontief and Cobb-Douglas (CD) options available as special cases. Cost minimisation drives the industry cost functions (equation (1)) and the factor demand functions (equations (7) and (8)).

The labour market assumptions used in this application are very simple. First the labour market is taken to be competitive. Second, we maintain a fixed unemployment rate, which means that the labour supply is determined as a constant proportion of the labour force (equation (5)), thereby replicating the extremely tight Jersey labour market. Third, as is explained in greater detail in

[3] AMOS is an acronym for *A M*acro-Micro Model *O*f *S*cotland. We have constructed an economic-environmental model for Scotland, AMOSENVI, but this at present uses adjusted UK, rather than Scottish-specific, pollutant and fuel use data.

Section 3, we exogenously impose alternative period-by-period evolutions of the Jersey labour force. The nominal wage in each time period is then derived through the interaction of the resulting vertical labour supply curve and the general equilibrium labour demand curve (equation (9)).

The four main components of commodity final demand (represented by equation (12)) are consumption, investment, government expenditure and exports. Household consumption is a linear homogenous function of real disposable income (equation (13)). Government expenditure is taken to be exogenous (equation (17)).[4] Exports are determined by exogenous external demand via an Armington link, making them relative price sensitive (equation (18)).

The modelling of investment demand is a little more complex. The process of adjustment of the capital stock at the sectoral level, which ultimately determines aggregate investment demand, is captured in the multi-period variant of the model in the following way. Within each period, both the total capital stock and its sectoral composition are fixed, and commodity markets clear continuously. The interaction between the fixed capital supply and capital demand at the sectoral level determines each sectors capital rental rate (equation (10)). Each sector's capital stock is then updated between periods via a simple capital stock adjustment procedure, according to which investment equals depreciation plus some fraction of the gap between the desired level of the capital stock and its actual level (equations (14) and (15)).[5] Desired capital stocks are determined on cost-minimisation criteria, using the user cost of capital as the relevant price of capital (equations (3) and (4)). The actual capital stock reflects last period's stocks, adjusted for depreciation and gross investment. In the base period the economy is assumed to be in long-run equilibrium, where desired and actual capital stocks are equal, with investment simply equal to depreciation. Investment as a source of product demand is then determined by running the demand for increased capital stock by sector through the capital matrix (equation (16)).

In the model, we do not impose macro-economic constraints, such as balance of payments or budget deficit limits or targets. However, we can track these surpluses. We also interpret the conceptual time periods of the model as years. We believe this to be justifiable in that the data used for calibration and, where applicable, for estimating the model are annual. Also, in these particular simulations, the primary disturbance to the model comes in the form of annual demographic changes.

The environmental component of the JEMENVI model is a block of equations relating the physical energy use (FUEL) and the generation of pollutants (POL) to the production of sectoral outputs and the level of final demand expenditures in the base year (equations (19) and (20)). That is to say, a set of fixed output- and expenditure-pollution coefficients are used to reflect the physical amount of fuel l used and pollutant k generated in the production of each monetary unit of sectoral output, Q_i, and final demand expenditure, C_z. For the final demands, pollutant and direct energy use figures are available for household consumption and tourist expenditure. We model eight types of fuel, eight individual pollutants, and one composite pollutant, an index of global warming potential (GWP Index).[6]

Parameterisation

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[4] In these simulations reported in this paper we have actually held constant government expenditure per head of population, but population is imposed exogenously.

[5] This process of capital accumulation is compatible with a simple theory of optimal firm behaviour given the assumption of quadratic adjustment costs.

[6] The eight fuels modelled are aggregate automotive fuels (petrol and derv), sulphur grade kerosene (kerosene SGK), low sulphur kerosene, gas oil, light fuel oil, heavy fuel oil, coal and gas. The eight individual pollutants are carbon dioxide (CO_2), methane (CH_4), sulphur dioxide (SO_2), nitrous oxides (NO_X), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), nitrogen dioxide (N_2O) and black smoke. The index of global warming potential (the GWP Index) is a weighted sum of CO_2, CH_4 and N_2O emissions, which enter the index with weights 1, 21 and 310 respectively.

The key economic structural characteristics of the JEMENVI model are parameterised on a Social Accounting Matrix (SAM) for Jersey for 1998 and the fuel-use and pollutant coefficients are similarly determined from a set of 1998 Jersey environmental satellite accounts (Turner, 2002). Key behavioural parameter values are imposed. No adequate data are available for econometric estimation of these parameter values for Jersey. Therefore, we chose these non-calibrated parameter values using data for comparable economies and informed judgement.

In the first instance, default settings for the following key behavioural parameter values have been set through consultation with the States of Jersey and the States' economic consultants following a review of parameter values used in models of comparable economies:

- Speed of adjustment of the actual to desired capital stock: 0.3
- Elasticities of substitution in production of (all activities)
  - Value added (capital and labour): 0.8 (CES)
  - Intermediates composite: 0.0 (Leontief)
  - Gross output (value added and intermediates composite): 0.0 (Leontief)
- Armington trade elasticities: imports 2.0, exports 5.0

3. Simulation Strategy

Simulations

We conduct four separate population-policy simulations using the JEMENVI model. These comprise combinations of two alternative population scenarios with two different assumptions about other economic conditions. The two population scenarios are associated with alternative migration assumptions. These are:

- Nil net migration.
- Limited net in-migration (200 people of working age *per annum*) over the period 2001 – 2011.

UK Government's Actuarial Department (UKAD) has quantified the demographic implications of these two options. Broadly, in the nil net migration scenario, natural demographic forces determine population changes. In fact the population is increasing but ageing, so that the projected working population is falling. The limited net in-migration scenario maps the demographic outcome if annual net in-migration of 200 workers aged 25 or under is permitted. We illustrate the changes in total and working population projected by the UKAD under the two scenarios, along with the resulting period-by-period change in total employment, in terms of percentage changes from the base year, 2001, in Figures 1 and 2.[7]

In the four simulations we combine each of the two population scenarios in turn with two economic scenarios regarding demand conditions:

- No exogenous demand changes to the economy.
- An increase in export demand of 50% for the output of the Finance sector

In the no-demand-change scenario, there are no changes to the exogenous demand parameters, apart from adjustments to maintain a fixed level of government expenditure per head.[8] In the second scenario, there is a 50% permanent step increase in UK and ROW Finance export demand that takes place in 2002. The sectors covered under Finance are the seven sectors 13-19 listed in Table A1.

[7] Note that the model can accommodate changes in total population period-by-period, but has to approximate working population changes with a linear trend, which is shown in Figures 1 and 2 as the JEM line.

[8] Neither are any supply-side disturbances, such as improvements in technical progress, imposed. In no sense are we attempting to forecast the economic performance of the Jersey economy over this time period.

In the first two simulations we model each of the migration scenarios in turn with no exogenous change in other economic circumstances: Simulation 1 with nil net migration and Simulation 2 with 200 net in-migration per annum to Jersey. In Simulations 3 and 4 we take each of these population scenarios and apply a 50% export demand shock to the Finance sector. Simulation 3 (a permanent 50% step increase in export demand to each of the sectors identified above that occurs in 2002). The results for all four simulations are compared to the base year values.

Our model is parameterised on data for 1998. However, we wish to identify the impacts of demographic changes projected to apply over the period 2001-2011. In reporting the results we assume the initial (base) data are appropriate for modelling the changes over this later period. That is to say, no attempt is made to adjust the initial structural characteristics of the model that might have changed over the 3-year period between 1998-2001. The proportional projected population and demand changes over the 11-year period 2001-2011 are therefore applied to the actual (1998) base year data.

The base year, 2001, is the period where the first population (demographic and/or migration) changes occur but the economic impact does not begin until 2002, when the labour force is updated. Thereafter population and labour force changes occur in every period up to and including 2011. As identified in Figure 1, the impact of the population change, which comes through changes in government expenditure, can be precisely captured in the model. However, the effect of the changes in the labour force is presently modelled by a linear trend that passes through the initial and final points of the 10-year series.[9]

Note that the results we report here are limited to the time period 2001 to 2011 (inclusive). However, since population changes occur in every period, there will be further adjustments beyond 2011 in response to all the scenarios being simulated before the economy returns to long-run equilibrium. While we do not do it here, the JEMENVI framework can be used to compute long-run results (with period-by-period results describing the adjustment process).

Sensitivity Analysis

For the four simulations we adopt the model configuration and default parameter values given in Section 2. Given the absence of econometrically estimated parameter values for Jersey, the next stage in the modelling process is sensitivity analyses. In Section 5, we report limited sensitivity results focussing on varying two of the key parameter values in the model. These are the Armington trade elasticities, which determine the sensitivity of export demand to changes in local output prices, and the elasticity of substitution between capital and labour in the CES production functions determining the composition of the primary input aggregate (value-added) in each sector. A key motivation for focussing on these parameters is the key role played by real household expenditure in determining the environmental impacts in each of the scenarios reported here. Since the main force driving changes in household income and expenditure is changes in labour demand, parameters have been identified which are important in determining the wage elasticity of demand for labour.

We limit the sensitivity analysis to the two scenarios where the most significant environmental impacts are observed. These are Simulation 3, where a 50% export demand shock to the Finance sector is introduced under the assumption of nil net migration, and Simulation 4, where the labour supply constraint is partially relaxed under these demand conditions, by allowing 200 in-migration per annum. We re-run these two simulations with the default (5.0) and four alternative values for

[9] Note that in Figures 1 and 2 the proportionate change in total employment resulting from the projected demographic changes is slightly larger than the change in total employment. This is because, due to the inclusion of non-participants and unemployed persons, working population in the base period (and all other years) is larger than total employment (labour supply).

the Armington elasticity of export demand, namely 0.5, 1.0 (Cobb-Douglas), 2.0 and 3.0, and the default. Similarly we use the default (0.8) and six alternative values for the constant elasticity of substitution between capital and labour, namely 0.1, 0.3, 0.5, 1.0 (Cobb Douglas), 1.2 and 1.5.[10] All other model specifications are unchanged.

4. Theory

Simulations

In this section we attempt to provide some analytical insight into the factors underlying the simulation results given in Section 5. We focus on the labour market and very simple supply and demand analysis. This is a natural approach given the nature of the disturbances and the concerns of Jersey legislators over the tightness of the labour market.

Figure 3 represents the interaction of the general equilibrium labour demand and supply curves in the unified Jersey labour market. The analysis is implicitly long run. Under the labour market closure adopted in all the simulations reported here, a constant unemployment rate is maintained. This implies a fixed proportional relationship between employment and the working population, producing vertical aggregate labour supply curves. The labour demand curve represents the relationship between the demand for labour and the wage in long-run equilibrium, with incomes, prices and, where appropriate, government expenditure endogenous.[11] The analysis is comparative static in that it identifies the impact on the equilibrium nominal wage and employment of disturbances to the general-equilibrium labour demand and supply curves. The equilibrium wage and employment levels are those towards which the economy is moving in the long-run, though note that the figures reported in Section 5 are for a time period over which full adjustment has not yet taken place.

The initial equilibrium is represented by the base-period (2001) labour demand and supply curves LD_B and LS_B, generating the initial equilibrium employment and wage levels w_B, N_B.[12] Simulation 1represents the nil net migration scenario accompanied by no exogenous change in export demand for the Finance sector. As discussed in Section 3, the nil net migration scenario is here associated with a fall in the labour force accompanied by a rise in population. This generates an inward shift of the labour supply curve, from LS_B to LS_0, and an outward shift in the general-equilibrium labour demand curve, from LD_B to LD_0. The expansion in labour demand reflects the increase in public sector activity required to maintain a fixed level of government expenditure per head of population. Thus the main direct impact of the population changes implied by the nil net migration scenario is a lower labour supply, with employment N_0, and a higher general wage level, w_0.

In Simulation 2, there is an expansion in the labour force and population through the net in-migration of 200 per annum over the 10-year period. This generates an outward shift of the labour supply curve to LS_{200}. In this case, although there is an increase in population we do not shift the labour demand curve as such linked changes in public expenditure have already been endogenised.[13] The effect is therefore simply to move the labour-market equilibrium down the labour demand curve LD_0, so that employment rises to N_{200}, but the wage falls to w_{200}.

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[10] Note that the model will not solve for 5 combinations in both cases (indicated by asterixes in Table 3). These are scenarios where labour demand becomes so wage inelastic that the model cannot adjust to a new equilibrium.

[11] The general-equilibrium labour demand curve is drawn as downward sloping. However, for combinations of extreme product demand and factor substitution elasticities, this is not necessarily the case (McGregor *et al*, 1995).

[12] Because there is no ambiguity, in this section we drop the subscript n on the wage term.

[13] There is some pedagogic value in treating all public expenditure as exogenous, so that there would be an additional outward expansion in labour demand in Simulation 2 as the population expanded further, accompanied by a labour

Simulation 3 introduces a 50% expansion in export demand in the Finance sectors, together with the nil net-migration scenario. An expansion in export demand shifts the labour demand function outwards to LD_X, as the value of the marginal product increases in these sectors. The appropriate equilibrium is therefore at the intersection of the demand curve LD_X and the labour supply curve LS_0. The wage rate rises to $w^X{}_0$ at an employment level of N_0. In Simulation 4, the employment constraint is again relaxed through in-migration but this time accompanied by the export demand shock to the Finance sector. The labour-market equilibrium is therefore at the intersection of labour demand curve LD_X and labour supply curve LS_{200}, generating a wage of $w^X{}_{200}$, together with an employment level of N_{200}.

The impact on other aggregate variables and the sectoral distribution of economic effects is discussed in more detail in Section 5. However, a number of general points can usefully be made here. The first is that whilst an expansion in the wage, *ceteris paribus*, reduces the competitiveness of Jersey output in relation to commodities produced off-Island, the increase in the wage relative to those commodities reflects an increase in Jersey's terms of trade and improvement in the real incomes for Jersey workers. In these terms, any in-migration increases competitiveness, but only at the expense of reduced real wages.

Second, the sectoral distribution of the output and employment changes that accompany the increase in the Finance-sector export demand shock will be very different to those that accompany the expansion in the labour supply through in-migration. The demand disturbance is focussed on one composite sector and the subsequent increase in wage will hit particularly hard other sectors producing export-orientated output. On the other hand, the expansion in labour supply will have a much more even impact across sectors as the fall in commodity price drives the expansion in output and employment across all sectors.

This shift between sectors can also have an important role in determining household income. This is because although we model the labour market as unified, this implies simply that the wage rates in all sectors change by the same proportionate amount in response to particular disturbances. However, the absolute level of the wage in some, particularly Finance, sectors is much higher than in others. Therefore a shift of labour into Finance, even without any change in the ruling wage rates, will increase household income.

Sensitivity Analysis

As outlined in Section 3, as an extension to the standard simulations, we undertake some sensitivity analysis. One function of such analysis is to show how vulnerable the measured economic and environmental results are to changes in the imposed parameter values. However, in this case the sensitivity analysis also has a more specific aim. This is to test whether an expansion in employment can actually reduce household income and thereby reduce pollutants whose production is closely linked to household expenditure. This is likely to occur where the labour demand function is inelastic.

As with Figure 3, Figure 4 represents long-run relationships in an economy with two alternative sets of behavioural parameter. These sets of parameters generate alternative initial (base) general equilibrium labour demand curves $LD_{L,B}$ and $LD_{H,B}$, where the subscripts L and H represent low and high elasticities respectively. Both sets of parameters, as is imposed by construction in CGE modelling, replicate the base data set. Therefore the initial equilibrium is where both these curves intersect the labour supply curve LS_B, that is where the nominal wage and employment are w_B, N_B.

We are keen to see how the wage, and particularly total wage income, varies with the elasticity of the labour demand curve when the economy is subject to the shocks corresponding to Simulations 3

demand curve which would be more wage inelastic than LD_0 (Turner, 2002). However, this renders the diagram extremely cluttered, so it is resisted here.

and 4. These are the simulations where there is a 50% expansion in export demand for the Finance sector. In Simulation 3 this is accompanied by the nil net migration scenario and in Simulation 4 the labour force constraints are relaxed through an in-migration of 200 per annum.

In Figure 4, the increase in demand for Finance-sector exports shifts the general equilibrium labour demand curves outwards from $LD_{.B}$ to $LD_{.X}$. Where the wage is fixed, both curves pass through the same point. This would be the extended Input-Output result (McGregor *et al* 1994, 1996). In the long run, if wage rates are held fixed, there will no changes in prices and therefore, with linear homogeneous production functions, no change in the cost-minimising production techniques. This implies that the Finance export demand stimulus will have the same output effect in both the high and low labour-demand elasticity versions of the model. This allows a reference point around which to anchor the two labour demand curves

For the I-O result to occur, the employment (and therefore labour supply) must rise to N_{IO}. However, the labour supply under the nil net migration scenario actually falls to N_0. The wage must therefore rise in order to bring labour demand and supply into equilibrium. The increase in the wage is higher, the more inelastic the labour demand curve. This is because the more inelastic the labour demand curve, the more difficult it is to switch to foreign products and other factor inputs as the wage rate rises. This means that $w^X_{L,0} > w^X_{H,0}$. Clearly, also total wage income, Nw, and therefore also household income, will be higher under the set of parameters that generate a lower labour demand elasticity.

In Simulation 4, the relaxation of the labour supply constraint will reduce the wage. This labour supply curve shifts outwards to LS_{200}. Employment will rise to N_{200} and the wage rates for the low and high labour demand elasticities fall to $w^X_{L,200}$ and $w^X_{H,200}$ respectively. Note that the lower the elasticity of labour demand, the greater the decline in the wage. Also, where this elasticity is less than unity, total wage income will fall as employment rises. If this occurs, it implies that $w^X_{L,0} N_0 > w^X_{L,200} N_{200}$.

5. Simulation Results

Economic Impacts

The percentage changes in key economic and environmental variables up to 2011 are given in Table 2 for all four basic simulations. The results for Simulation 1, where there are no exogenous changes in external demand conditions combined with nil net migration, are shown in the first column of results. The impact on economic activity is slightly negative: Gross Domestic Product (GDP) falls by 0.46% by 2011. This is primarily because of the reduction in labour supply as an input to production that accompanies the ageing of Jersey's population.

Note that the decline in GDP is less than the drop in employment (-0.76% by 2011). This partly reflects the small stimulus to demand as government spending increases in line with population growth. Moreover, capital stocks do not fall by as much as employment. There are two reasons for this. First, the increase in real wages causes firms to substitute capital for labour. Second, the downward adjustment of capital is subject to frictions due to capital fixity, so that in the short to medium-run it is easier for firms to reduce employment than capital. These factors combine to ensure GDP does not fall by as much as employment and, therefore, GDP *per employee* actually rises. However, because of the increasing population, GDP *per head* falls, and does so even more rapidly than GDP, although again by a relatively small amount: by the end of 2011GDP per head is 1.68% lower than the 2001 (base year) level.

The tightening of the labour market causes an increase in both nominal and real-consumption wages across the economy and a rise in the Consumer Price Index (CPI). However, the scale of these increases is small – all change by less than 0.6% by 2011. Two points are important concerning these CPI results. First, they only demonstrate step changes in Jersey prices and do not chart an inflationary process. Second, the limited impact on the CPI is due to the fact that only local prices, not import prices, are rising: we assume that all external prices remain constant. The increase in local input prices negatively affects competitiveness across all sectors in the Jersey economy; relative to goods produced off-Island. This causes a contraction in output and employment in most sectors. However, despite the fall in competitiveness, output and employment actually rise in the four government sectors – Education, Health, Social Work & Housing, Public Services and Public Administration. This is because, with the exception of Education, these sectors are *sheltered* from external competition, i.e. they only serve local demand and do not export their output. Consequently, the government sectors are less affected by the rise in the relative prices than other sectors of the economy. Further, these sectors experience a direct demand boost through the increase in government expenditure that is required to maintain spending per head constant. However all the other sectors exhibit negative output and employment effects.

The extent of the negative impact on a particular sector is determined by two factors. First, labour intensive sectors are hit hardest by the increased cost of labour. Secondly, sectors that are more open to international trade feel the negative competitiveness effects more strongly. Agriculture and Fishing suffers the most due to a combination of these two factors and Hotels, Restaurants and Catering is hit relatively hard for the same reasons. On the other hand, Banks and Building Societies suffers the least, partly because it is the least labour intensive sector in the economy and partly because it uses relatively few locally produced inputs, and therefore experiences the lowest competitiveness effect.

In Simulation 2, the labour force constraint is relaxed in terms of allowing 200 in-migration per annum. The impact on key economic and environmental variables, measured in terms of the percentage change from base year values, is given in the second column of Table 2. The increase in the labour force reduces the tightness in the labour market leading to a subsequent expansion in the economy. There are positive impacts in terms of employment and GDP, which more than outweigh the negative effects observed when migration is suppressed. However, the proportionate increase in GDP is lower than the rise in population, so that GDP per head falls further than under nil net migration scenario. Note also that the expansion in activity is accompanied by a reduction in the real wage level in the economy, an outcome that is not necessarily in the interest of existing Jersey residents.

In Simulation 3 we introduce the 50% export-demand shock to the Finance sector under the nil net migration scenario. By 2011, none of the Finance sectors actually experience a full 50% increase in exports. This is because increases in their output prices – i.e. decreases in competitiveness - ensure that this amount is never actually achieved. However, as can be seen in column 3 of Table 2, there is a sizeable impact on GDP, which increases by 9.11% by 2011.[14] However, predictably, the shortage of labour and increase in export demand combine to push up both real wage and the CPI, which increase by 5.23% and 2.22% respectively. This compares with the increases of only 0.42% and 0.13% in Simulation 1, where there was no exogenous demand shock.

The expansion of output in the Finance sector leads to increases in employment in that aggregate sector, but a fall in employment in other sectors. As would be expected, the biggest losers are non-Finance sectors that are highly export- and/or labour-intensive, such as Agriculture & Fishing,

[14] However, note that, while it is not reported here, we find that the impact on Jersey GNP is much more limited, only increasing by 2.65% by 2011. This is due to the high degree of foreign ownership in the Jersey Finance sector, which means that a significant proportion of the additional income from the export demand boost in Simulation 3 accrues to non-Jersey residents.

Wholesale & Retail Trade, Hotels, Restaurants & Catering, Land Transport, and Sea & Air Transport sectors.[15]

Simulation 4 combines the Finance export demand shock with a 200 *per annum* net in-migration. This expansion in the labour force partly mitigates the negative effects on individual sectors of the export demand shock. If one compares the results reported in column 4 of Table 2 with those in column 3, competitiveness and GDP rise as a result of the expansion in the labour force, though the real wage falls.

An interesting comparison can be made between the results generated by relaxing the labour-force constraint both with and without the expansion in the export demand for Finance. This involves comparing the change in results as one moves from Simulation 1 to Simulation 2, which we will label ΔSim2, with the change between Simulation 3 and Simulation 4, ΔSim4. Specifically, the changes in GDP are surprisingly similar in the two cases. For ΔSim2, GDP increases by an additional 2.041% by 2011 and for ΔSim4 by 2.197%.[16] Why does adding the export shock make so little difference?

At the margin, all firms bid for workers on a level playing field and the additional workers are distributed across sectors according to their demand for labour. This is quite different to the situation in reported in Simulation 3, where hundreds of employees move into Finance from other sectors with a corresponding increase in GDP of 9.11% by 2011. Rather, the extra employees in ΔSim4 are distributed across sectors in a relatively even fashion. The slightly higher additional impact on GDP of the expansion in the labour force that is found in ΔSim4 can be attributed to the increase in the productivity of the Jersey economy as a whole that is caused by the Finance export demand shock. In Simulation 3, the effect of that demand stimulus is to increase GDP per head by 7.89%. This is almost exactly the increase in additional GDP reported in ΔSim4, as against ΔSim2. That is to say, an increase of 7.89% to the figure 2.041% (the increase in GDP in ΔSim2) gives 2.202%, marginally above the figure for the increase in GDP in ΔSim4.

However, one key observation can be made. In Simulation 2, we find that the additional impacts of allowing 200 net in-migration per annum are enough to outweigh all the negative effects on activity and prices of the demographic changes in the nil net migration scenario reported in Simulation 1. This is not true in the presence of a 50% increase in Finance sector export demand. The positive impacts on output, employment and competitiveness across all sectors in Simulation 4 are not enough to outweigh the negative ones in Simulation 3 for a number of sectors. Similarly the downward pressure on the real wage level and CPI from allowing 200 in-migration per annum is not enough to combat the upward pressure on both these variables in nil net migration case where the export demand shock is present. In other words, while allowing 200 net in-migration per annum does ease economic conditions, the economy is still sufficiently labour constrained to cause crowding out of activities and general upward pressure on prices.

Environmental Impacts

The key factor determining the environmental impacts of all four simulations is the effect on the level of real consumer expenditure in Jersey. This is because household consumption is the dominant factor determining the level of emissions of most of the major pollutants identified in the model. This particularly applies to traffic-related emissions because local households are the main

[15] It is important to note that the Finance sector, as defined here (following the States of Jersey's policy requirements) is a rather heterogeneous group of sectors. Not all experience an increase in employment: Other Business Services is an example.

[16] The change in the real wage and CPI are very similar too, but it is the GDP change that is given prime policy significance in Jersey.

consumers of automotive fuels in Jersey.[17] One local environmental problem that particularly concerns policymakers is the impact of traffic-related emissions generation and congestion in the main urban area of St. Helier. As explained in Section 2, JEMENVI has been developed to model the generation of a number of individual air pollutants, including emissions of CO, N_20, NMVOC, CO_2 and NO_X from the combustion of automotive fuels (petrol and derv) in different types of vehicle. However, in the results reported in Table 2 we limit our attention to the simulation results for automotive fuel-use, as the source of traffic-related emissions and an indicator of total vehicle use or congestion, and the composite Global Warming Potential (GWP) Index (see below).[18]

Under the nil net migration scenario captured in Simulation 1, all traffic-related emissions fall (in fact emissions of all pollutants fall) as activity across the whole economy contracts. Note from the first column of Table 2 that automotive fuel use in the government sectors increases, though only by 0.48%. This is a result of the increase in total government expenditure required to maintain a fixed level of spending per capita as total population rises. Indeed there is a general increase in energy use and pollution generation in the government sectors, but this is not generally sufficient to offset the negative effects of reduced activity elsewhere in the economy.

The addition of either the demand shock or positive migration generates an increase in automotive fuel-use and traffic-related emissions as against the 2001 base level. The biggest impact on automotive fuel-use is observed in the cases where a 50% increase in Finance-sector export demand is present. This is because increases in activity are concentrated in the high wage Finance sectors, thus increasing the level of real income and expenditure per household. Generally when the population constraint is relaxed (with or without the export demand shock), all types of energy use, water use and pollution generation increase as the level of activity in all sectors improves.

However, we have seen that the demand shock does crowd out a number of activities. This generates the 3.54% decline in automotive fuel-use in the non-government production sectors and the 22.25% reduction in tourist use reported for Simulation 3. Agriculture & Fishing is the production sector that suffers the greatest proportionate decline in activity following its reduced competitiveness as the real wage and local input prices rise. This sector is a key energy user and producer of a number of pollutants. However, the primary pollutant associated with agricultural activities in Jersey is methane (generated by livestock).[19] Methane is a major component of the Global Warming Potential (GWP) Index, which is widely accepted as an indicator of the impact of individual economies on the climate change problem.[20]

The increase in the GWP Index in the presence of the demand shock is less significant than the increase in traffic-related emissions. In Simulation 3, the GWP Index increases by only 1.82% compared to an increase in total automotive fuel use of 5.96%. The GWP Index is influenced by traffic-related emissions CO_2 and N_2O, which increase by 2.78% and 4.56% respectively. However the weight attached to methane, and the absolute reduction in the emissions of this pollutant due to the crowding out of agricultural activity, serve to pull the value of the increase down. Note, however, that when in-migration occurs, there is a marked increase in GWP emissions due to the general increase in activity, both agricultural and non-agricultural, in the economy, with an additional 2.61% increase in emissions in ΔSim4 on top of the 1.82% reported for Simulation 3.

[17] In 1998 local households directly accounted for 70.5% of total automotive fuel use in Jersey. Indeed, in the absence of a heavy industrial sector, households are directly responsible for most types of emissions generation in Jersey. See McGregor *et al* (2001) and Turner (2002) for a full analysis of emissions generation in Jersey in 1998.

[18] A fuller account of the environmental impacts of the four simulations discussed here is given in Turner (2002).

[19] In 1998 82.7% of total methane emissions were directly generated in the Agriculture & Fishing sector (see Turner, 2002).

[20] The States of Jersey is a party to several international agreements on environmental issues. For example, the States' Environmental Charter, endorsed in 1996, includes a commitment to the principles agreed at the Earth Summit in Rio De Janeiro in 1992 regarding greenhouse gas emissions (States of Jersey, 1998).

However, in Simulation 4 the total percentage change in the GWP Index remains lower than the change in either CO_2 or N_2O, reflecting the overall fall in methane emissions, even with migration.

In terms of the policy debate in Jersey regarding the costs and benefits of population expansion, note that while allowing 200 net in-migration per annum over the period 2001 to 2011 does have a positive impact on GDP, the magnitude of the impact is not very significant. The additional impact on GDP from allowing this population expansion is only 2.04% by 2011 in Simulation 2 (with no exogenous change in demand). The trade-off in terms of the environmental impacts of allowing the population to increase in this way is proportionate increases in the value of the GWP Index and total automotive fuel-use (and therefore traffic-related emissions) in Jersey that are greater than the increase in GDP. The additional impacts (ΔSim2) on the GWP Index and total automotive fuel-use of allowing 200 in-migration per annum are 2.67% and 2.41% respectively by 2011. Moreover, the results suggest that such an expansion in population would not be in the interest of existing Jersey residents, with the real wage level in the economy and GDP *per capita* falling with 200 in-migration per annum in Simulation 2.

On the other hand, the biggest positive GDP effect, 9.11% by 2011, is observed in Simulation 3, where activity is stimulated by an increase in export demand to the Finance sector, with no expansion in population from allowing in-migration. Moreover, the impact on the GWP Index, which increases by only 1.82% by 2011, is not as great as that observed under the 200 net in-migration per annum scenario in Simulation 2. However, in assessing the full environmental cost of the demand shock relative to stimulating activity by relaxing the labour market constraint, note that the increase in total automotive fuel use in Simulation 3, 5.96% by 2011, is proportionately greater than the additional impact of in-migration in Simulation 2 (2.41%). Moreover, the larger expansion in GDP, and smaller increase in the GWP Index, from the export demand shock in Simulation 3 involves sectoral shifts in activity, with crowding out in a number of sectors, particularly in Agriculture & Fishing, Wholesale & Retail Trade, Hotels, Restaurants & Catering and the transport sectors. This may have important distributional effects, particularly given that firms in these sectors tend to be under local ownership, while the main Finance sectors, such as Banks & Building Societies and Investment Trusts and Fund Managers are largely foreign-owned.

Sensitivity Analysis

As argued in Section 3, we lack appropriate data to econometrically parameterise some of the key behavioural relationships in the JEMENVI model. Further, we find that the magnitude of the impact of any disturbance on automotive fuel use, and therefore traffic-related emissions, is sensitive to the precise assumptions made about the key parameters determining the wage elasticity of the general equilibrium demand for labour. This is because the impact on automotive fuel use is mainly determined by what happens to the level of real household income and expenditure, which is strongly influenced by aggregate payment to wages. Table 3 shows the proportionate changes in Real Household Income and Expenditure and Total Automobile Fuel Use for Simulation 3 and the additional impact of Simulation 4 (ΔSim4). These figures are calculated for various combinations of values for the key parameters, the elasticity of substitution of capital and labour in the production of value added, σ, and the Armington price elasticity of export demand, η.

As explained in Section 4, we would expect that in the case of the export demand shock in Simulation 3, the more wage inelastic labour demand is – i.e. the smaller the values of σ and η - the bigger will be the positive impact on real wages. While not reported here, the sensitivity results for the impact on the real wage level in Simulation 3 broadly follow this pattern.[21] However, the

[21] Disequilibrium effects are clearly present in the case of $\eta = 0.5$, the lowest value we consider for the Armington elasticity of export demand Recall that the sensitivity analysis, as with all the simulation reported here, relates to the

consequent impact on household income and expenditure depends not just in changes in the general wage level, but also on the composition of employment across different sectors with different initial actual wage rates. In Simulation 3, where a large export demand shock directed at the Finance sectors causes labour to shift into relatively high wage activities, *ceteris paribus*, we would expect to observe a significant positive impact on real household income. However, where the price elasticity of export demand, η, is high the size of the actual demand shock realised in Simulation 3 will be limited. Where this is combined with a low elasticity of substitution into between capital and labour, i.e. a low value of σ, the impact on income from employment will be even smaller. The results in Table 3a reflect this. Also at lower values of η some disequilibrium effects are again clearly present.

The sensitivity results for the impact on total automotive fuel use (Table 3b) are in line with the findings for total real household income and expenditure. The impact on automotive fuel use is in all cases smaller in proportionate terms than the impact on household income and expenditure because of the downward pressure from reduced activity elsewhere in the economy, but its magnitude is just as sensitive to what we assume about the values of σ and η.

However, the most interesting results are found in Tables 3c and 3d that report the sensitivity analysis of the household income and expenditure and automotive fuel use impacts in ΔSim4, where the effects of relaxing the labour force constraint are identified. In the initial simulations reported earlier in this section, we find that the additional impacts of allowing 200 in-migration per annum are universally detrimental on all environmental indicator variables. This is mainly because of the upward pressure on the level of total household consumption, which is the main source of most types of pollution, particularly traffic-related emissions, in the Jersey economy. However, we have speculated that if labour demand is sufficiently wage inelastic, the reduction in real wages from relaxing the labour supply constraint may be enough to offset the increase in employment, with the implication that total household income and expenditure must fall. This in turn may lead to some types of pollution generation in the economy falling as the aggregate level of activity increases. In Section 3 we explain that this possibility is the main motivation for focussing our initial sensitivity analyses on the parameters that determine the elasticity of labour demand.

In the default ΔSim4, where $\sigma = 0.8$ and $\eta = 5.0$, total household income and expenditure increases by an additional 1.98% by 2011 when 200 net in-migration per annum is allowed in the presence of the 50% increase to Finance sector export demand. However, Table 3c reveals that the *direction* of this effect *is* sensitive to what we assume about the elasticity of substitution between capital and labour. Specifically, if the value of σ is assumed to be 0.1 (in all sectors), total household income and expenditure falls as output and employment rises in all sectors of the economy. This is independent of the value of η. If the elasticity of export demand, η, is reduced to 0.5 the net impact on total household income and expenditure is almost zero where $\sigma = 0.5$, and negative where $\sigma = 0.3$.

However, in terms of actual policy analysis, one would have to consider the plausibility of labour demand in Jersey actually being as highly inelastic as is required to bring about this decline in total household income and expenditure. Moreover, note from Table 3d that the decline in household consumption is only sufficient to bring about a net decline in *total* automotive fuel use in the case where $\sigma = 0.1$ and $\eta = 1.0$ (Cobb Douglas). Although we do not report it here, in this one case the net impact on emissions of the main traffic-related pollutants, NMVOC, CO and N_2O, is also negative. However, we find that the additional impact on all other types of pollution is uniformly positive regardless of what we assume about the substitutability of labour for capital or

end of time period studied, 2011, which is not a long-run equilibrium. Given that the population changes are still occurring in 2010, the capital stock is not fully adjusted to bring the economy to long-run equilibrium by 2011.

the price elasticity of export demand. This is due to the increase in productive activity across the economy when the labour supply constraint is partially relaxed.

6. Conclusion

This paper has focused on the impact of relaxing the labour force constraint within the Jersey economy through increased in-migration. We have tracked the economic and environmental impacts over a 10-year time period with two alternative assumptions over export demand. These assumptions are of an unchanged level of export demand and then a 50% expansion in export demand for the Finance sector.

The main findings are that the expansion in GDP that is associated with the relaxation of the labour force constraint is relatively small. This applies even where there has been a substantial expansion in the Finance export demand. Further, this expansion in local activity following increased migration reduces the real wage and GDP per head. The expansion in output has impacts on congestion and pollution, particularly on the Global Warming Potential Index, which Jersey is committed to reduce. However, the in-migration modelled here might have one positive characteristic from a policy perspective. An expansion in export demand in the Finance sector leads to sectoral disruption as employment is pulled into the expanding sectors. In-migration, which eases the labour shortage over all sectors, could reduce these sectoral tensions.

These points having been made, it is important to highlight some key characteristics of the model used here and to suggest further avenues of work that we would wish to pursue. The first is that in this paper we have not explicitly modelled migration. Rather we have imposed a particular demographic projection made on the assumption of a particular flow of in-migrants. Ideally the mechanism by which migration is regulated should be identified and used to generate the appropriate migration flow. This links directly to a second issue. In the model at present we have only one Jersey-specific resource, labour. The policy scope and power of the model would be expanded by the to incorporation of land and housing. Land use is a key environmental issue on the Island and restrictions on house-building and home ownership are thought to be important mechanisms by means of which migration is controlled.

A third issue is skill disaggregation. The impact of in-migration is likely to differ if the skill composition of in-migrants is very different from that of the population as a whole. We know that in the UK migration differs markedly by skill type and this might be a characteristic of Jersey migration too. Again, if migration is related to entrepreneurship, an increase in migration might be associated with other supply side changes in the economy. A final point is that pollution and energy use is modelled in a rather elementary way in the model as it stands. The use of fixed output and expenditure coefficients for the prediction of environmental effects does not fully exploit the flexibility of CGE models (Beauséjour *et al*, 1994, 1995; Bergman, 1990, 1991). All these issues are ones we wish to return it in further work.

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APPENDIX

Table A.1 Sectors (Activities/Commodities) Identified in JEMENVI

No	Sector	Jersey/UK Standard Industrial Classification (JSIC 1995, UK SIC 1992)
1	Agriculture & Fishing	01, 05
2	Quarrying & Construction	14, 45
3	Manufacturing	15 – 18, 20, 22, 25-26, 28-31, 33,35, 37
4	Electricity	40.1
5	Water	41
6	Gas, Oil & Fuel Distribution	40.2,50.50,52.48
7	Telecommunications	64.2
8	Wholesale and Retail Distribution	50 – 52
9	Hotels & Restaurants	55
10	Land Transport	60.2, 60.3
11	Sea & Air Transport and Transport Support	61, 62, 63
12	Post	64.1
13	Banks & Building Societies	65.121, 65.121, 65.21, 65.22, 65.233, 65.234, 65.235 & 65.236
14	Insurance Companies	66
15	Investment Trusts & Fund Managers	65.231, 65.232, 67
16	Computer Services	72
17	Legal Activities	74.11
18	Accountancy	74.12
19	Other Business Activities	70, 71, 73, 74.13 - 74.8
20	Other Service Activities	91, 93
21	Recreation, Culture & Sport	92
22	Education	80
23	Health, Social Work & Housing	85
24	Public Services (Sewage & Refuge Disposal)	90
25	Public Admin. & Defence	75

Tables

Table 1: A Condensed Version of the JEMENVI CGE Model

(1) Commodity Price	$p_i = p_i(w_n, w_{ki})$
(2) Consumer Price Index	$cpi = \sum_i \theta_i p_i + \sum_i \theta_i^{UK} \overline{p}_i^{UK} + \sum_i \theta_i^{ROW} \overline{p}_i^{ROW}$
(3) Capital Price Index	$kpi = \sum_i \gamma_i p_i + \sum_i \gamma_i^{UK} \overline{p}_i^{UK} + \sum_i \gamma_i^{ROW} \overline{p}_i^{ROW}$
(4) User Cost of Capital	$uck = uck(kpi)$
(5) Labour Supply	$N^S = (1-\overline{u})\overline{L}$
(6) Capital Sock	$K_{i,t}^S = (1-d_i)K_{i,t-1}^S + \Delta K_{i,t-1}$
(7) Labour Demand	$N_i^D = N_i^D(Q_i, w_n, w_{k,i})$
(8) Capital Demand	$K_i^D = K_i^D(Q_i, w_n, w_{k,i})$
(9) Labour Market Clearing	$\sum_i N_i^D = N^S = N$
(10) Capital Market Clearing	$K_i^S = K_i^D$
(11) Household Income	$Y = \Psi_n N w_n + \Psi_k \sum_i K_i w_{k,i}$
(12) Commodity Demand	$Q_i = C_i + I_i + G_i + X_i$
(13) Consumption Demand	$C_i = C_i(p_i, \overline{p}_i^{UK}, \overline{p}_i^{ROW}, Y, cpi)$
(14) Desired Capital Stock	$K_i^* = K_i^D(Q_i, w_n, uck)$
(15) Capital Stock Adjustment	$\Delta K_i = \lambda_i(K_i^* - K_i)$
(16) Investment Demand	$I_i = I_i(p_i, \overline{p}_i^{UK}, \overline{p}_i^{ROW}, \sum_i b_{i,j}\Delta K_j)$
(17) Government Demand	$G_i = \overline{G_i}$
(18) Export Demand	$X_i = X_i(p_i, \overline{p}_i^{UK}, \overline{p}_i^{ROW}, \overline{D}^{UK}, \overline{D}^{ROW})$
(19) Pollutants	$POL_k = \sum_i m_{i,k} Q_i + \sum_z m_{z,k} C_z$
(20) Physical Energy Use	$FUEL_l = \sum_i \varepsilon_{i,l} Q_i + \sum_z \varepsilon_{z,l} C_z$

NOTATION

Activity-Commodities
i, j are activity/commodity subscripts.

Transactors
UK = United Kingdom, ROW = Rest of World

Functions

p (.)	cost function
uck(.)	user cost of capital formulation
$K^D(.)$, $N^D(.)$	factor demand functions
C(.), I(.), X(.)	Armington consumption, investment and export demand functions, Homogenous of degree zero in prices and one in quantities

Variables

C	consumption
D	exogenous export demand
G	government demand for local goods
I	investment demand for local goods
ΔK	investment demand by activity
K^D, K^S, K^*, K	capital demand, capital supply, desired and actual capital stock
L	labour force
N^D, N^S, N	labour demand, labour supply and total employment
Q	commodity/activity output
X	exports
Y	household nominal income
b	elements of capital matrix
cpi, kpi	consumer and capital price indices
d	physical depreciation
p	price of commodity/activity output
u	unemployment rate
uck	user cost of capital
w_n, w_k	wage, capital rental
Ψ	share of factor income retained in region
θ	consumption weights
γ	capital weights
λ	capital stock adjustment parameter
POL_k	quantity of pollutant k
m_{ik}	output-pollution coefficients
m_{zk}	(final demand) expenditure-pollution coefficients
$FUEL_l$	quantitity of energy/fuel type l
ε_{il}	output-energy use coefficients
ε_{zl}	(final demand) expenditure-energy use coefficients

***Note* (*):** A number of simplifications are made in this condensed version of JEMENVI

1. Intermediate demand is suppressed throughout (e.g. only primary factor demands are noted in price determination in equation (1) and final demands in the determination of commodity demand in equation (12).
2. Income transfers are generally suppressed.
3. Taxes are ignored.
4. The participation rate is ignored.
5. There are implicit time subscripts on all variables. These are only stated explicitly in the capital undating equation (6).

Table 2: Summary Simulation Results – Percentage Change By 2011 From Base Year (2001) Values

	Simulation			
	No Finance Demand Shock		Finance Demand Shock	
	1	**2**	**3**	**4**
	Nil Net Migration	200 Net In-Migation p.a	Nil Net Migration	200 Net In-Migation p.a
GDP	-0.46	1.58	9.11	11.31
GDP per head	-1.68	-2.27	7.89	7.46
Real Wage	0.42	-1.04	5.23	3.65
Real HH Income & Expend.	-0.33	1.52	11.73	13.71
Total Employment	-0.76	2.82	-0.76	2.82
CPI	0.13	-0.23	2.22	1.86
Total automotive fuel use	-0.52	1.89	5.96	8.36
Government sector	0.48	3.07	3.55	6.18
Other production	-0.76	2.39	-3.54	-0.48
Households	-0.33	1.52	11.73	13.71
Tourists	-1.77	3.95	-22.25	-17.60
GWP Index	-0.50	2.17	1.82	4.43

Table 3: Summary Sensitivity Analysis Results -
Percentage Change in Household Income and Expenditure and Total Automotive Fuel Use by 2011

(a)Real Household Income And Expenditure
Nil Net Migration - % change from base year (2001) values

CES elasticity of Subsitution - K/L	Armington elasticity of export demand				
	0.5	CD (1)	2	3	**5**
1.5	*	*	17.16	15.35	12.95
1.2	*	20.50	17.30	15.20	12.55
CD (1)	24.17	21.08	17.37	15.04	12.20
0.8	25.56	21.78	17.40	14.77	**11.73**
0.5	28.63	23.08	17.17	14.00	10.70
0.3	32.02	*	16.48	12.96	9.69
0.1	*	24.02	14.69	11.35	8.59

(b)Total Automotive Fuel Use
Nil Net Migration - % change from base year (2001) values

CES elasticity of Subsitution – K/L	Armington elasticity of export demand				
	0.5	CD (1)	2	3	**5**
1.5	*	*	11.21	9.41	7.18
1.2	*	14.01	10.94	9.00	6.72
CD (1)	16.94	14.11	10.71	8.67	6.36
0.8	17.53	14.22	10.44	8.29	**5.96**
0.5	18.91	14.45	9.87	7.53	5.22
0.3	20.61	*	9.24	6.81	4.60
0.1	*	14.62	8.22	5.91	3.96

(c)Real household income and expenditure
Additional % change from base year (2001) values resulting from 200 net in-migration p.a.

CES elasticity of Subsitution - K/L	Armington elasticity of export demand				
	0.5	CD (1)	2	3	**5**
1.5	*	*	2.02	2.17	2.29
1.2	*	1.57	1.93	2.08	2.20
CD (1)	0.98	1.45	1.84	2.00	2.11
0.8	0.72	1.27	1.70	1.87	**1.98**
0.5	0.01	0.79	1.31	1.49	1.62
0.3	-1.08	*	0.66	0.88	1.07
0.1	*	-3.26	-2.11	-1.68	-1.30

(d)Total Automotive Fuel Use
Additional % change from base year (2001) values resulting From 200 net in-migration p.a.

CES elasticity of Subsitution – K/L	Armington elasticity of export demand				
	0.5	CD (1)	2	3	**5**
1.5	*	*	2.14	2.31	2.48
1.2	*	1.77	2.12	2.29	2.46
CD (1)	1.30	1.71	2.09	2.26	2.44
0.8	1.16	1.63	2.03	2.21	**2.41**
0.5	0.74	1.37	1.84	2.06	2.30
0.3	0.05	*	1.50	1.78	2.12
0.1	*	-1.10	0.03	0.61	1.39

FIGURES

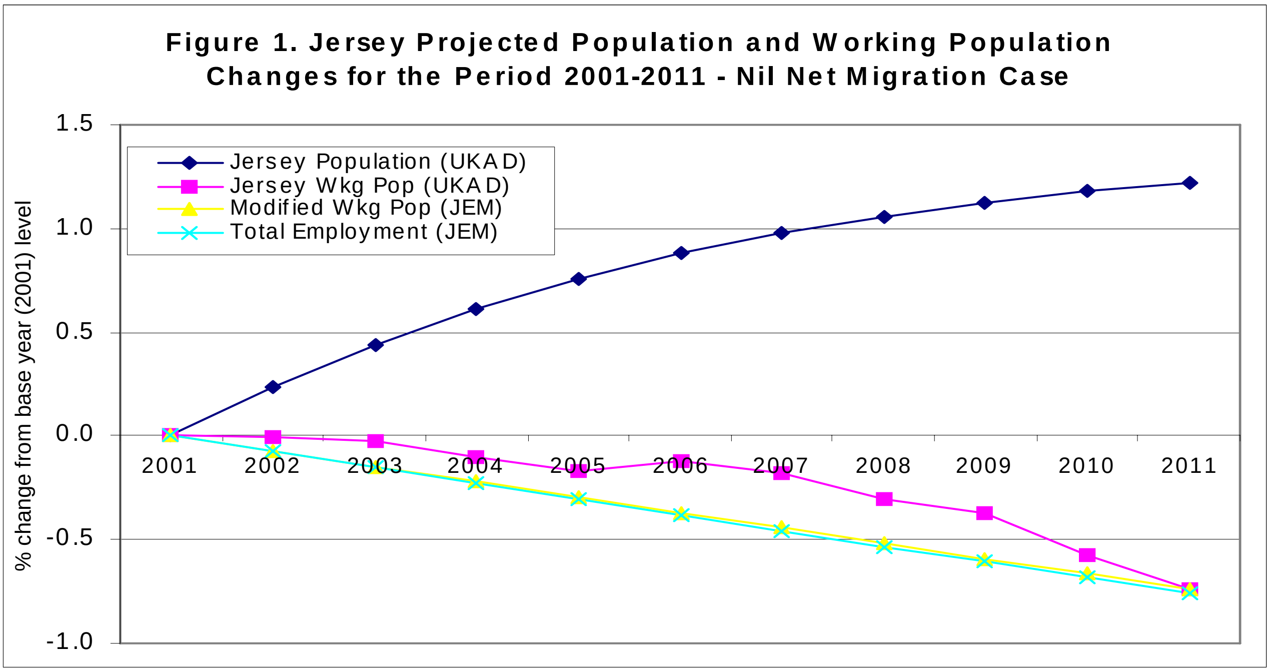

Figure 1. Jersey Projected Population and Working Population Changes for the Period 2001-2011 - Nil Net Migration Case
Jersey Population (UKAD)
Jersey Wkg Pop (UKAD)
Modified Wkg Pop (JEM)
Total Employment (JEM)
% change from base year (2001) level
1.5
1.0
0.5
0.0
-0.5
-1.0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

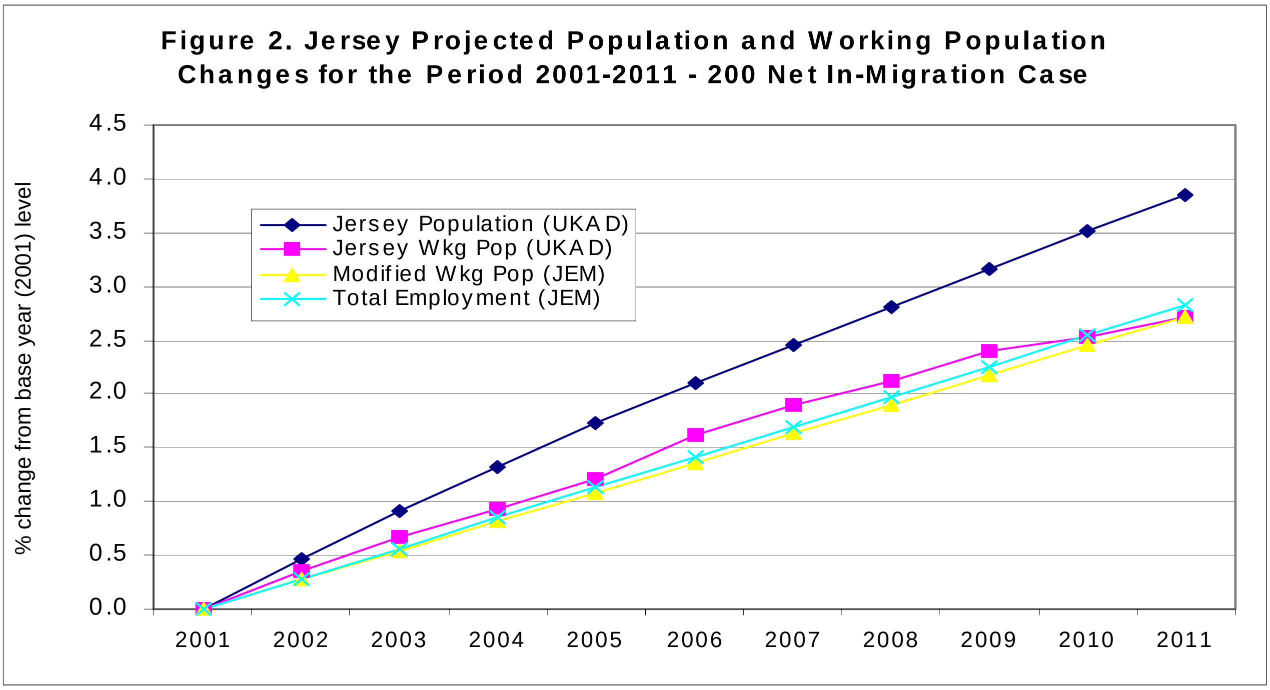

Figure 2. Jersey Projected Population and Working Population Changes for the Period 2001-2011 - 200 Net In-Migration Case
Jersey Population (UKAD)
Jersey Wkg Pop (UKAD)
Modified Wkg Pop (JEM)
Total Employment (JEM)
% change from base year (2001) level
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

Figure 3. General Equilibrium Labour Supply and Demand under the Population and Demand Shock Scenarios Simulated

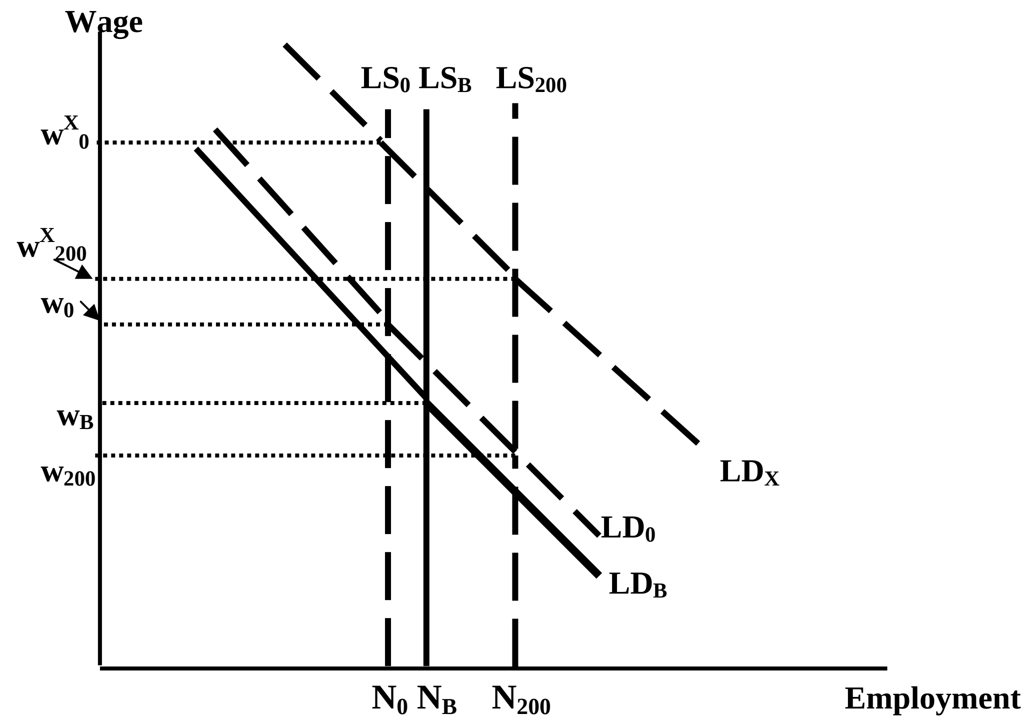

Figure 4. General Equilibrium Labour Supply and Demand under Different Assumptions About the Elasticity of Labour Demand