Abstract

In this project, we explore the effects of Singapore's foreign labour policies on local employment rates. We also created an ABMS model that allows us to vary the policies and observe their effects. With the results from the model, we then evaluate the necessity and effectiveness of these policies. We also evaluate if more needs to be done to protect jobs for local workers.

Introduction

As a small country with a declining fertility rate and ageing population, Singapore is highly dependent on foreign labour to supplement its workforce and remain competitive in the global market.

Among local Singaporeans, there has been growing concern in recent years that foreign workers are "stealing" local workers' jobs. To allay these fears and ensure that there are sufficient jobs for local workers, the Government has implemented a number of policies and restrictions on the hiring of foreign workers.

There are many factors to be considered when employers are choosing between a local and a foreign worker for the same job. Therefore, we need an ABMS model to help us easily fine-tune the various factors to find a good balance between having sufficient foreign workers to supplement our workforce, while ensuring that local workers are not deprived of jobs.

Literature Review

In 2021, local Singaporean workers made up the majority of the workforce in Singapore, at about 67.1%. Work permit holders make up the largest proportion of foreign workers, at about 23.3%, followed by Employment and S Pass holders at about 4.4% each.

Lower-wage foreign workers in sectors like construction and cleaning are accepted by Singaporeans as they are needed to do the jobs that Singaporeans eschew. However, skilled professionals, managers and executives (PMEs) at higher level S Pass and Employment Pass salaries, are the ones who are viewed to be in direct competition with Singaporeans for better paying jobs. There is concern among local PMETs[1] that they will be unfairly treated by their employers in favour of younger, equally or higher skilled EP and S Pass holders.

Therefore for this project, we will be focusing on jobs that require skilled labour. So, we will only consider local workers and foreign workers who hold either the Employment Pass or the S Pass.

To ensure companies can access foreign professionals of the right quality and build up their local staff over time, Singapore utilises salary requirements to restrict the number of highly-skilled foreign workers. There are also additional restrictions placed on employers who wish to hire S-pass holders.

	Employment Pass	S Pass
Type	Managerial, Executive or Specialised	Mid-skilled
Qualifications	University degree/ Professional qualifications/ Specialised skills	Degree / Diploma
Minimum Qualifying Salary	$4,500 per month $5,000 per month for candidates in the financial services sector	$2,500
Quota	NIL	10-18% of company's total workforce
Levy Rate	NIL	Up to 10% of total workforce: $330 Above 10-18% of total workforce: $650

Table 1. Summary of the requirements (before 2022) for S-Pass and E-Pass Holders

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[1] PMETs: Professionals, Managers, Executives and Technicians

The difficulty that the Government now faces is how to calibrate these policies to ensure that the supply of foreign workers meets the needs of the workforce. Too restrictive, and there will not be enough workers to fill up the vacancies in our labour market. Firms may also not want to operate in Singapore due to the overly-restrictive regulations. Too loose, and there may not be enough jobs available for local workers; and they might end up having to accept much lower salaries. This is why we are using ABMS to simulate the effect of the policies and how they affect local employment rates.

To improve the competitiveness of local workers, there are also various schemes to assist them in upgrading their skills to prepare them for new jobs. For this project, we will be focusing on SkillsFuture, which provides Singaporeans with resources and training to upgrade their skills.

Hypotheses

Hypothesis 1: Increasing the minimum qualifying salary for the S Pass and the Employment Pass helps to improve the employment rates of local workers.

Hypothesis 2: SkillsFuture helps improve the employment rates of local workers, even if there are many highly-skilled foreign workers in Singapore.

Model Overview

For our model, we assume that all employers and all employees are rational.

For employers, they evaluate applicants based on an arbitrary measure called "profit" that is associated with each applicant.
- Profit consists of the potential revenue gain they get from hiring the applicant, minus the costs of hiring that applicant.
- Revenue is derived from applicant's' skill and aptitude.
- Cost consists of the applicant's expected salary, as well as any additional costs associated with hiring foreign workers if the applicant is a foreign worker.

Since these are measures and relative between each applicant, they can be numerically negative.

We assume that employers only select the applicants with the highest profit value.
Similarly, we assume that job seekers will only select the job offer with the highest offered salary.

For every tick in our model, we run one full hiring cycle. We have split the hiring cycle into 4 stages, with the flow diagrams shown for more complex decision making processes.

Stage 1: Preparing for the Hiring Cycle (Employers & Workers)
In this stage, Employers determine the number of available vacancies that they still have. Employed workers use this stage to determine if they want to retire or change their jobs. Unemployed workers decide if they want to upskill to improve their employability, or do nothing.
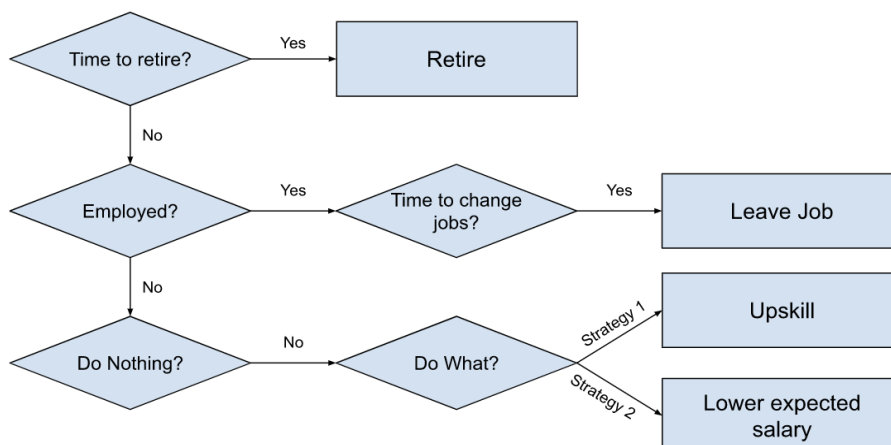

Figure 1. Decision making process for Workers (Employed & Unemployed)

Stage 2: Job Applications (Workers only)

Unemployed workers apply to companies near them that match their skill levels and salaries.
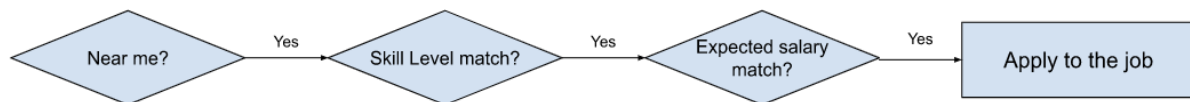

Figure 2. How unemployed workers choose where to apply to.

Stage 3: Applicant Selection & Job Offers (Employers only)

Employers will evaluate the list of applicants, sorting the applicants via their profit value. Note that the cost calculation for the profit value will differ based on whether the applicant is a local or foreigner.
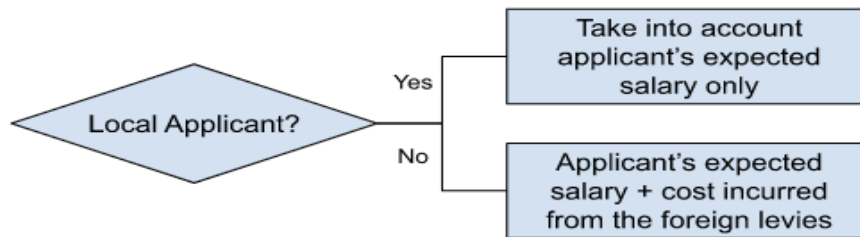

Figure 3. How employers determine the cost of hiring that applicant

After the list of applicants has been sorted, employers will then send out offers to the applicants until they have no more vacancies. Note that the number of offers that can be sent out to the SP applicants is restricted by the SP quota cap.
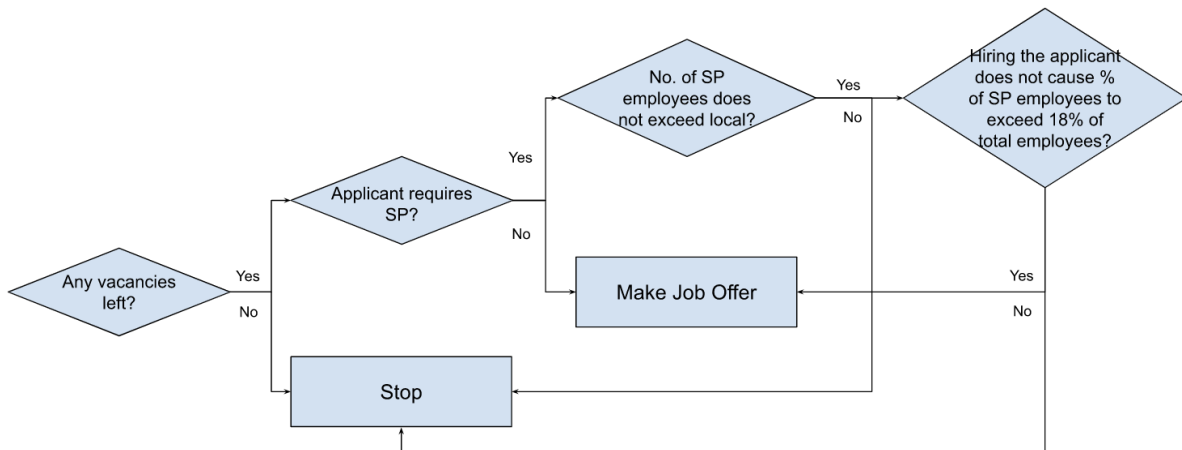

Figure 4. How employers process and hire their applicants

Just before employers send job offers to the successful applicants, they will determine the offer salary. In order to secure the best workers, employers try to offer competitive salaries. This is determined with a simple fictitious play implementation:

Each employer stores a historical list of their past base offer salary (salary that would be offered to a worker of the lowest skill). Employers reference competitors' lists and choose from three strategies to determine the base offer salary.
- Highest (take maximum of all historical offers)
- Average (take average),
- Most Frequent (take the mode)

Employers' competitors are other employers of the same size as them, as in real life, it is rare for a large company to be in direct competition with a smaller company due to the difference in resources.

Stage 4: Job Acceptances (Workers)

Workers accept the job offer that offers them the highest salary.

Parameter Descriptions

Variable	Formula	Explanation of Dependent Variables	Justification
market_val How much this worker is worth in the market.	$skill\ score\ *$ $basic\ worker\ pay$	skill_score: determined by workers' education level basic_worker_pay: salary worker with skill_score of 1 should receive	A measure or value assigned to workers based on overall industry and sites like PayScale. Should increase with skill score.
exp_salary (local worker) Local worker's expected salary.	$market\ val\ +\ random$ $(\frac{skill\ score\ *\ 2}{100}\ *\ market\ val)$	Previously defined	Random percentage based on skill score higher than market_val. Accounts for workers researching their market_val and likely asking for higher than they deserve at their current skill level. Random as this differs across workers.
exp_salary (foreign worker) Foreign worker's expected salary	Set to minimum qualifying salaries for the EP / SP if market_val is lower. Otherwise: $market\ val\ +\ random($ $\frac{skill\ score}{100}\ *\ market\ val)$	Previously defined	Similar to local workers' above. However, the extra percentage is lower. Assumes foreign workers would not tend to ask for more than what a local would.
revenue_from_hire An arbitrary measure of the "revenue" an employer stands to gain from hiring this worker.	Skill_score > 3: $basic\ worker\ output\ *$ $skill\ score\ *\ apt\ score$ Skill_score <= 3: $basic\ worker\ output\ *$ $(1\ +\ \frac{skill\ score\ +\ apt\ score}{100})$	basic_worker_output: base output a worker with skill_score of 1 would produce, arbitrary measure, changes with skill apt_score: aptitude score, determined randomly	Scaling varies based on worker's skill_score to ensure revenue increases with skill and aptitude but also assumes higher skill workers will produce as much as they would demand in terms of exp_salary
base_offer_salary Employer's offer salary to a worker with skill_score = 1. Initialised with formula. Changed based on competitors' values.	$basic\ worker\ pay\ +$ $random$ $(\frac{size}{100}\ *\ basic\ worker\ pay)$	size: intrinsic variable, employer's size (ie. small / medium / large / MNC)	Employers may have an offer salary rate above or below the average rate, which can be influenced by their size (larger, more resources).
num_vacancies No. of vacancies of each employer.	$capacity\ -$ $num\ local\ employees\ +$ $num\ ep\ employees\ +$ $num\ sp\ employees$	capacity: max no. of workers, based on employer size, grows by 0.1% every hiring cycle	Assumes employers want to staff to full capacity. Hence vacancies is the capacity minus all current employees (local, EP, SP).

Table 2. List of formulae used in the hiring cycle

Measurements Taken (Plots, BehaviourSpace)

Reporter	Method(s)	Justification
percentage-employed Percentage of local / foreign workers who are employed. Denoted by "Local Employment" or "Foreign Employment"	$\dfrac{No.\,of\,employed\,foreigners}{Total\,no.\,of\,foreign\,workers} * 100$ $\dfrac{No.\,of\,employed\,locals}{Total\,no.\,of\,local\,workers} * 100$	Basic measure of employment based on worker type.
percentage-local-workforce Percentage of all employed workers who are locals. Denoted by "Local Workforce"	$\dfrac{No.\,of\,employed\,locals}{Total\,no.\,of\,employed\,workers} * 100$	Expected to decrease if barriers to entry are lowered for foreigners. Related to concerns about the number of foreign workers in the workforce.
percentage-unemployed-skilled-locals Percentage of all skilled and able local workers who are unemployed.	$\dfrac{No.\,of\,unemployed\,skilled\,locals}{No.\,of\,skilled\,locals} * 100$ Workers with skill_score > 3 and apt_score > 2 are considered "skilled".	Expected to increase if barriers to entry are lowered for foreigners. Related to concerns about jobs being taken from skilled locals. The higher this percentage, the more likely jobs are being taken by foreigners from locals.

Table 3. Measurements used in BehaviorSpace

Results Descriptions

Experiment setup:

To test the two hypotheses, we set up 4 BehaviorSpace experiments, to see the effects of varying the Minimum Qualifying Salary (MQS) on local employment rates, and also to find out if upskilling did improve local employment rates.

foreign_levy	330
num_foreign_workers	2000
num_local_workers	4000
num_employers	200
runs	30

Table 4. Variables that were kept constant in all 4 experiments.

Tabulation of results

	Local employment	Foreign employment	Skilled local unemployment	% of workforce being local
Low MQS	95.612	95.821	4.137	64.528
Low MQS (RS)	95.687	95.696	3.828	64.543
High MQS	95.720	95.753	4.137	64.538
High MQS (RS)	95.735	95.706	3.790	64.557

Table 5. Results of the 4 BehaviorSpace Experiments

Experiment 1: Low MQS (SP: 2000, EP: 4000), no reskilling
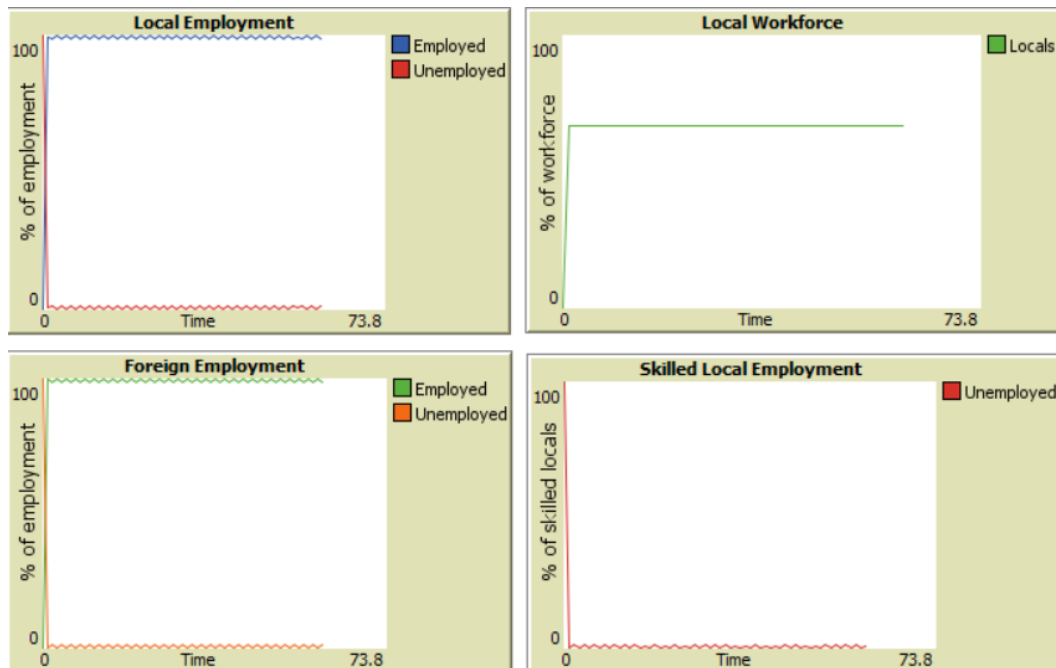

Figure 5. The results of the effects of a low MQS and no reskilling

Experiment 2: High MQS (SP: 3000, EP: 5000), no reskilling
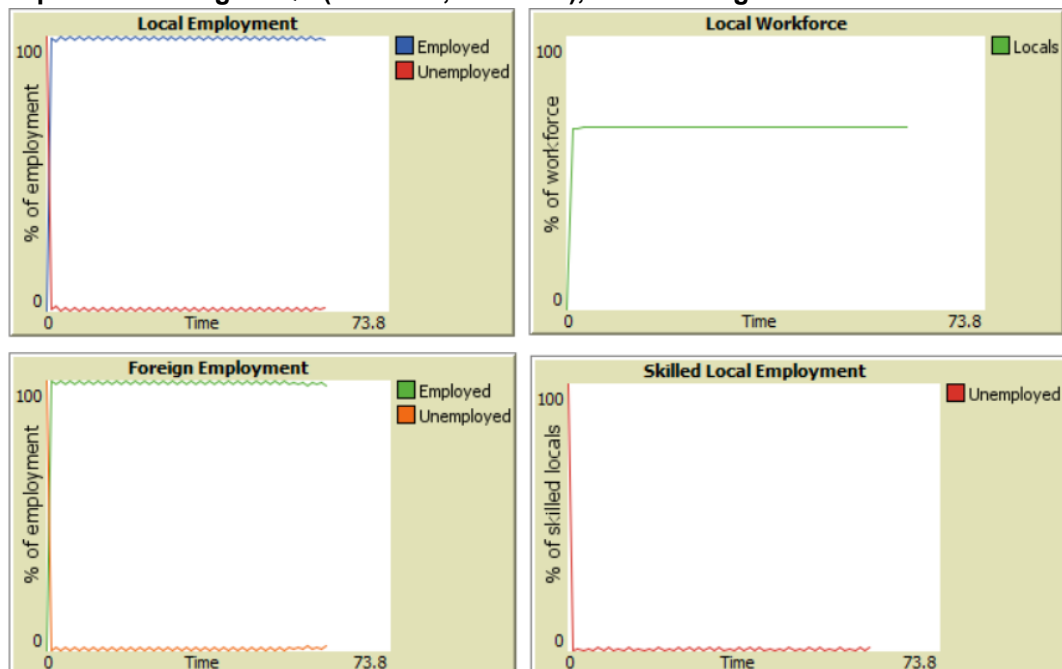

Figure 6. The results of the effects of a high MQS and no reskilling

From the first two experiments, we can see that increasing the minimum qualifying salary improves local employment rates. This is because when the minimum qualifying salary increases, it is more expensive for employers to hire foreign workers, so they are more motivated to shift to hiring local workers instead. That being said, we cannot increase the minimum qualifying salaries too high as it will hurt employers who can no longer afford to hire foreign workers, but cannot find sufficient local workers to hire.

Experiment 3: Low MQS (SP: 2000, EP: 4000), reskilling

Figure 7.The results of the effects of a low MQS and reskilling

Experiment 4: High MQS (SP: 3000, EP: 5000), reskilling

Figure 8.The results of the effects of a high MQS and reskilling

From the next two experiments, we can see that reskilling also has a positive effect on local employment rates, regardless of whether the MQS is set to high or low. This indicates that reskilling is indeed effective in improving local workers' competitiveness (and thus attractiveness to employers), and is an essential strategy the government should continue to invest in to improve local employment rates.

Verification & Validation of Model

This model is essentially a simplified version of Singapore's labour market, with a focus on how the foreign labour policies affect local employment rates. Therefore, we have utilised the key elements of job hunting (by workers) and job offers (by employers), creating a model that is simplified, but effective and easy to understand.

To make the model more relevant to real-life conditions, we had also implemented a simple fictitious play algorithm in the way that employers calculate offer salaries. This allows our model's employers to offer more competitive salaries, similar to how companies in real life compete for stellar candidates.

Future Enhancements/Improvements

Our model assumes that the labour market is stable and not affected by external factors, like pandemics or other unpredictable events. However, we cannot deny that such events have a drastic impact on the labour market, and might make some factors more significant than before.

For future extensions of the model, this is what we would like to do:
● Conduct more extensive research into factors considered by policy makers, and implement methods to simulate those factors (e.g. Singapore's changing population demographic).
● Conduct more extensive research into other forces influencing the labour market, e.g. how human factors like bias and interview performance affect hiring decisions.
● Simulate the impact of the different types of unemployment (e.g. Cyclic & Structural) .
● Calculate the economic impact if the entry barrier for foreign workers is raised.
● Tie the components of the model more closely to Singapore's population demographics.

Conclusion

Recently, the Government has decided to raise the minimum qualifying salaries, starting from 2022 onwards. The results of our experiments support the Government's decision, as we had indeed observed an improvement in local employment rates when minimum qualifying salaries were raised.

However, our results only showed a small increase in employment rates. This is likely due to the fact that our model's calculations did not take into account other important considerations which policy makers do when making these decisions.

Acknowledgements

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