Education, informality and the pandemic: explaining the unequal impacts of Covid-19 in the Mexican labour market

Garcia Lazaro, Aida and Martin, Chris and Okolo, Magdalyn

University of Bath

2022

Education, Informality and the Pandemic: Explaining the Unequal Impacts of Covid-19 in the Mexican Labour Market

Aida Garcia-Lazaro* University of Bath

Chris Martin† University of Bath

Magdalyn Okolo‡ University of Bath

August 10, 2022

Abstract

The impact of the Covid-19 in Mexico was especially severe for non-graduates and for workers in informal employment. We argue that this occurred despite the adverse shocks from the pandemic being similar for all workers, because non-graduates and informal workers are in a weaker position in the labour market. We support this argument by presenting novel evidence of shorter job tenures and higher rates of transition from employment to non-employment for these workers and by showing that simulation of a DSGE model with the same shocks for all workers matches the experience of Mexico during the pandemic well. To do this, we develop an innovative model that differentiates between graduates and non-graduates as well as between formal and informal workers; the key feature of our model is that the job surplus for non-graduates and informal workers is smaller, making these workers more vulnerable to adverse shocks. Our results are likely to be applicable to other emerging economies with large numbers of informal workers.

Keywords: Covid-19; Mexico; Search Frictions; DSGE model

JEL Classification: E23, E32, J23, J30, J64

Acknowledgements

We thank participants at a joint Bath/Bristol/Exeter seminar on Development Economics. Declarations of interest: none.

*ajgl21@bath.ac.uk; Institue for Policy Research, University of Bath, Bath BA2 7AY UK.

†cim21@bath.ac.uk; Department of Economics, University of Bath, Bath BA2 7AY. Corresponding author. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

‡muao20@bath.ac.uk; Department of Economics, University of Bath, Bath BA2 7AY UK.

1 Introduction

The Covid-19 pandemic had a severe and disruptive impact in Mexico. In the second quarter of 2020, GDP fell by 17% and employment fell by 20%. Across 2020, GDP fell by 8.5% and employment by 5.6%. These adverse impacts were not spread evenly across the labour market. They were especially severe for non-graduates and for workers in informal employment. By the third quarter of 2020, employment of non-graduates had fallen by 2.5 million, compared to job losses of 0.5 million for graduates. And over 2 million informal jobs had been lost, compared to a fall of less than 1 million formal jobs. The impact of the pandemic on other emerging economies with large numbers of informal workers was similar (Furceri et al., 2020; ILO, 2020*b*,*a*).

Understanding the impact of the Covid-19 pandemic on Mexico and on similar economies requires an explanation of the disproportionately large impact on non-graduates and informal workers. There are two broad approaches to this. The first is that the shocks associated with the pandemic were especially severe for these workers; we refer to this as the *severe shocks* hypothesis. The second is that the shocks impacting on non-graduates and informal workers were no more severe than the shocks that hit other types of worker; rather, the pandemic had larger impacts on these workers because they were in a weaker position than other workers in the Mexican labour market at the onset of the pandemic. We refer to this as the *same shocks* hypothesis. In this paper we argue that the evidence supports the same shocks hypothesis.

We support this argument in two steps. First, we show that non-graduates were in a weaker labour market position when the pandemic hit, by presenting novel evidence of shorter job tenures and much higher rates of transition from employment to non-employment for non-graduates compared to graduates. Second, we show that simulation of a DSGE model under the same shocks hypothesis is able to match the experience of Mexico during the pandemic well; in particular, it can match the very different changes in employment of graduates and non-graduates as well as formal and informal workers.

This simulation cannot be done using existing models, since these distinguish between formal and informal jobs but not between graduates and non-graduates. In this paper, we therefore develop an innovative model that differentiates between graduates and non-graduates as well as between formal and informal workers. The key feature of our model is that non-graduates and informal workers are more likely to be employed in jobs that generate a smaller surplus. Pre-pandemic, this smaller surplus manifested in the shorter job tenures and much higher rates of transition from employment to non-employment for non-graduates compared to graduates that we document in this paper. During the pandemic, the small surplus made job matches with these workers more likely to break down than matches with other types of workers; this is the mechanism through which simulations of our model are able to match the larger impacts of the pandemic on non-graduates and informal workers, even though all workers are hit by the same shocks.

This paper proceeds in four stages. Section 2) documents the different impacts of the pandemic on graduates and non-graduates and on those employed in formal and informal jobs. We focus on the first dimension, since the differing impacts by formality have already been documented (e.g., Leyva and Urrutia, 2021). We show that losses in employment were more severe for non-graduates in both formal and informal jobs, suggesting that education was the dominant factor in determining the impact on workers at the onset of the pandemic. We also show that the recovery from the pandemic that began in the latter part of 2020 was concentrated in informal employment; there was a rise in informal employment for both graduates and non-graduates that partially offset earlier losses. For both types of worker, the recovery in formal jobs was much smaller[1]. Section 3) then develops a model that can explain these facts. We take a standard New Keynesian DSGE model with search frictions in the labour market, and formal and informal imperfectly competitive retail firms who respectively sell formal and informal goods to households and the government. We extend this model in order to distinguish between four types of job match: those involving graduates employed in formal jobs, graduates in informal jobs, non-graduates employed in formal jobs and non-graduates in informal jobs. In section 4), we calibrate our model using data from the immediate pre-pandemic period, 2018Q2-2019Q4. In section 5), we simulate our model using a set of shocks that are designed to replicate the impact of the Covid-19 pandemic and where the magnitude of the shocks is the same for all workers. We show that our simulations provide a good match to the experience of the Mexican labour market during the pandemic. Finally, in our conclusions, we comment on the applicability of our results to other emerging economies with large proportions of informal workers.

2 The Impact of the Pandemic on the Mexican Labour Market

2.1 The Pre-Pandemic Labour Market

Our primary data source is the National Survey of Occupation and Employment (ENOE).[2] In this survey, individuals are classified as either (i) employed;[3] (ii) unemployed (working age individuals who report they were actively looking for a job); (iii) available (available to work but had not looked for a job in the last four weeks) and (iv) non-available. As we document in the Online Appendix, large numbers of unemployed and non-available workers transition into employment in each quarter. We therefore combine categories (ii)-(iv) into one group,[4] which we label as the non-employed.[5]

We distinguish between graduates and non-graduates and between formal and informal jobs. Following ENOE practice, an informal job is one that does not give permanent employment or social security benefits and where the employer is invisible to the tax authorities and evades labour market regulations (OECD (2019) and Dix-Carneiro et al. (2021)).[6] For the period 2018Q2-2019Q4, immediately before the pandemic, an average of 12.3% of the workforce were graduates employed in formal jobs. And 7.6% of the workforce were graduates employed in informal jobs in the same period.[7] Among non-graduates, 10.5% of the workforce

[1] Alberola and Urrutia (2020) have argued that the relative flexibility of informal jobs, compared to formal jobs, creates a buffer that helped insulate the Mexican labour market from adverse shocks in the pre-pandemic era. Our findings suggest that this buffer was overwhelmed by the size of the Covid-19 shock, but that the increased flexibility enabled a faster recovery in informal employment once the initial Covid-19 shock had passed.

[2] Participants remain in the ENOE survey for five quarters: `http://en.www.inegi.org.mx/programas/enoe/15ymas/default.html`. In order to calculate job transition rates, we only include households who also participated in the survey in the previous quarter in our sample. As a result, we use 80% of the full sample in every quarter. In the Online Appendix, we show that the structure of employment and the pattern of informality in our sample is similar to that in the full sample of participants.

[3] "Employed" refers to any individual of working age engaged in an occupation; this includes the employed and the self-employed.

[4] As we outline below, our model has 6 distinct labour market categories and 12 flows between formal and informal sector employment and non-employment. Distinguishing between unemployment and inactivity would imply analysing 8 labour market categories and 24 labour market flows, which is infeasible. Using longitudinal ENOE survey data, Leyva and Urrutia (2020) show that the behaviour of unemployment and inactivity is similar across the business cycle, although unemployment is more volatile.

[5] One important source of transitions between non-employment and employment comes from the intermittent pattern of female labour market participation. The labour market experience of many women in Mexico exhibits recurrent swings between non-employment and spells of temporary and part-time employment, often in informal jobs (Arceo-Gomez and Campos-Vazquez, 2010); this pattern is a significant impediment to the ability of many women to develop a career (Vargas et al., 2015).

[6] We note that informality characterises the job rather than the firm, so a worker at a formal firm that does an informal job is classified as being informal. This distinction is important, since slightly over 50% of workers in informal jobs are employed in formal sector firms.

[7] Classifying jobs as being either high- or low-skill (using the International Standard Classification of Occupations, ISCO), we find that large majority of jobs in high-skill occupations are filled by graduates in both the formal and informal sectors.

were employed in formal jobs while 23.4% were non-graduates employed in informal jobs. So approximately 50% of those working in the formal sector were graduates, compared to only 25% of those working in the informal sector. And approximately one-in-three graduates and one-in-two non-graduates did not have paid employment in the pre-pandemic period.[8], These data are summarised in Figure 1).[9]

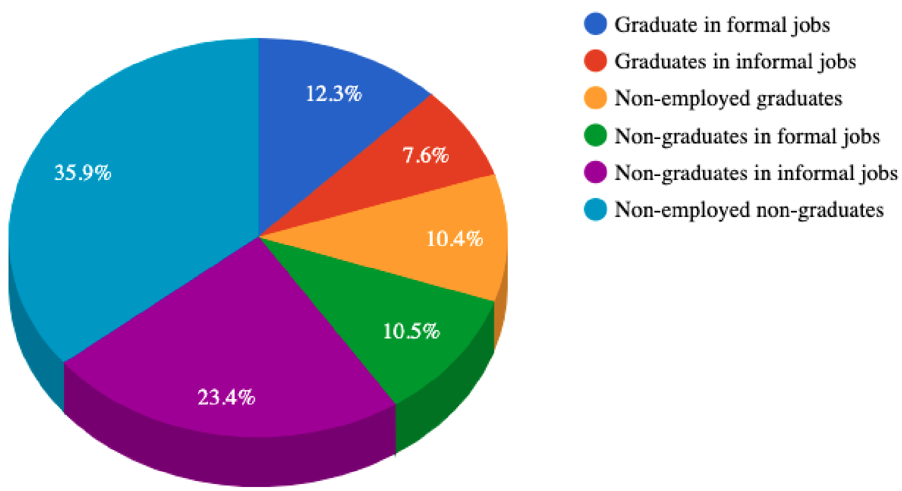

Figure 1: **Employment in Mexico, 2018Q2-2019Q4**
Source: Authors' calculations using ENOE data.

Table 1) documents transition rates in the pre-pandemic period, 2018Q2-2019Q4. We note that structural inequalities in the Mexican labour market are manifested in higher rates of job destruction and lower rates of hiring for non-graduates. Job destruction rates are systematically higher for non-graduates than for graduates in both formal and informal jobs; a non-graduate in an informal job is nearly three times more likely to move into non-employment than a graduate in a formal job. And although hiring rates into informal jobs are similar for graduates and non-graduates, a graduate is three times more likely to be hired into a formal job than a non-graduate. We argue that these differences in rates of job transition reflect differences in the values of different types of job match, so the surplus from job matches is systematically lower for non-graduates than for graduates.

2.2 The Mexican Labour Market During the Pandemic

Figure 2) documents the dramatic changes in employment between 2020Q1-2020Q3 and 2020Q3-20202Q4.[10] Close to 3 million workers left employment between 2020Q1-2020Q3. These losses were concentrated among non-graduates. To highlight this, we note that non-graduates accounted for 67% of job losses between

And the great majority of jobs in low-skill occupations, in either sector, are filled by non-graduates, see the Online Appendix.

[8]This is similar to Alberola and Urrutia (2020), who calibrate their model to give an employment rate of 50%.

[9]The informality rate, the share of employment at informal firms in total employment, is 42% This is similar to Alberola and Urrutia (2020), who calibrate to give an informality rate of 50%.

[10]The immediate impact of the pandemic on employment in Mexico, in April-June 2020, is difficult to track since ENOE suspended normal data collection in that period, using the Telephonic Survey of Occupation and Employment (ETOE) instead. Although ETOE data should be treated with some caution, this survey highlights the very severe initial impact of the first wave of Covid-19 on the Mexican labour market. ETOE data shows that 10 million people lost their jobs in the second quarter; of these, 80% were in informal jobs. Since the consistency of ETOE with ENOE is unclear, we decided not use ETOE data in this paper.

Table 1: **Labour Market Transitions in Mexico, 2018Q2-2019Q4 and 2020Q1-2020Q3**

i) Graduate Transitions	Formal Jobs	Informal Jobs	Non-employment
Formal Jobs	0.810, 0.758	0.114, 0.111	0.076, 0.131
Informal Jobs	0.206, 0.193	0.600, 0.518	0.194, 0.290
Non-employment	0.095, 0.080	0.149, 0.134	0.756, 0.786

ii) Non-Graduate Transitions	Formal Jobs	Informal Jobs	Non-employment
Formal Jobs	0.702, 0.644	0.201, 0.211	0.097, 0.145
Informal Jobs	0.088, 0.074	0.702, 0.639	0.210, 0.287
Non-employment	0.028, 0.021	0.146, 0.132	0.827, 0.848

Notes: This table documents (a) transition rates between 2018Q2-2019Q4 (in blue); and (b) transition rates between 2020Q1-2020Q3 (in red). Source: Authors' calculations using ENOE data.

2021Q1-Q3 despite only accounting for 61% of employment. By contrast, graduates only accounted for 33% of job losses despite accounting for 39% of employment. These differences are much less marked for the formal/informal distinction: formal employment was 43% of employment in 2020Q1 and accounted for 44% of job losses, while informal employment was 57% of employment in 2020Q1 and accounted for 56% of job losses. This evidence supports our focus on the impact of the pandemic on non-graduates. Figure 2) also documents the recovery in employment in the final quarter of 2020. As discussed above, this recovery largely consists of an increase in informal jobs.

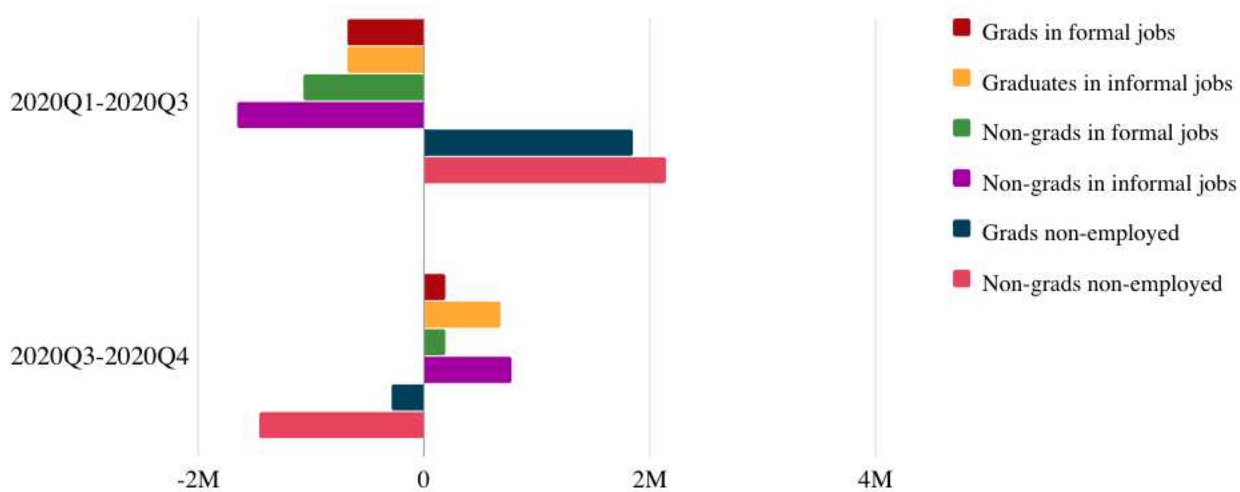

Figure 2: **Employment Changes in Mexico, 2020Q1-2020Q4**
Source: Authors' calculations using ENOE data.

Table 1) documents how the pandemic affected labour market transition rates. We note that proportional increases in rates of job destruction and reductions in rates of hiring are larger for graduates and for formal workers. The rate of job destruction for graduates in formal jobs increased by 72%, from 0.076 to 0.131; the comparable increase for non-graduates was 49%, from 0.097 to 0.145. Rates of job destruction for graduates in informal jobs increased by 49%, compared to 37% for non-graduates. The hiring rate into formal jobs fell by 92% compared to a fall of 25% for non-graduates, while hiring rates into informal jobs fell by 10% for both graduates and non-graduates. The disproportionate impact of the pandemic of non-graduates documented in Figure 2) arises because of the systematically higher rates of job destruction, and lower rates of hiring for these workers. This evidence argues against the severe shocks hypothesis, and supports the same shocks hypothesis showing that vulnerable workers were more severely affected by the pandemic.

3 The Model

The previous section has documented the different experiences of graduates and non-graduates in the Mexican labour market, working in formal and informal jobs, before and during the pandemic. In this section, we develop a model that is designed to explain these differences. The existing literature analyses one dimension of this, accounting for differences between the formal and informal sectors. But it does not consider the other dimension, since it does not distinguish between graduates and non-graduates.

In the existing literature that features formal and informal employment, Restrepo-Echavarria (2014), Fernandez and Meza (2015) and Horvath (2018) use Real Business Cycle-type models, in which all markets are frictionless and competitive. Colombo et al. (2019) and Alberola and Urrutia (2020) use a New Keynesian framework with nominal rigidities. Colombo et al. (2019), Leyva and Urrutia (2020), Alberola and Urrutia (2020) and Leyva and Urrutia (2021) assume there are search frictions in the formal labour market but not the informal labour market. Leyva and Urrutia (2020) and Alberola and Urrutia (2020) assume there is only self-employment in the informal sector, whereas Colombo et al. (2019) model informal employment by including informal sector firms, citing evidence in La Porter and Shliefer (2008). The existing literature does not model the flows of worker between formal and informal sectors that are revealed in Table 1).

Our model builds on the existing literature: the key innovation is that we distinguish between graduates and non-graduates on the basis of the evidence in section 2). We assume there are search frictions in both formal and informal labour markets and follow Colombo et al. (2019) in modeling informal sector firms.[11] In order to account for the evidence of flows of workers between formal and informal sector jobs, documented in Table 1), we assume that all workers search for employment in both formal and informal sectors. Our evidence-based decision to combine unemployed, “available” and “non-available” workers into a single category implies that the decision of whether to participate in the labour market is not relevant in our model. We use a New Keynesian framework with nominal rigidities in order to be able to include aggregate demand and monetary policy shocks in our simulations of the impact of the pandemic. Our model is summarised in Figure 3). Our model has four distinct labour markets, i) graduates in formal firms, ii) graduates in informal firms, iii) non-graduates in formal firms, and iv) non-graduates in informal firms. In each, firms post vacancies and hire workers who are either non-employed or employed in a different type of firm. There are shocks to aggregate demand, to monetary policy, to the relative demand for formal and informal goods, to productivity and to job destruction. We assume that productivity and job destruction shocks are the same for each of the four types of employment, in order to test our hypothesis that structural differences in the Mexican labour market imply that shocks that are the same for all workers have more severe impacts on non-graduates and on informal workers.

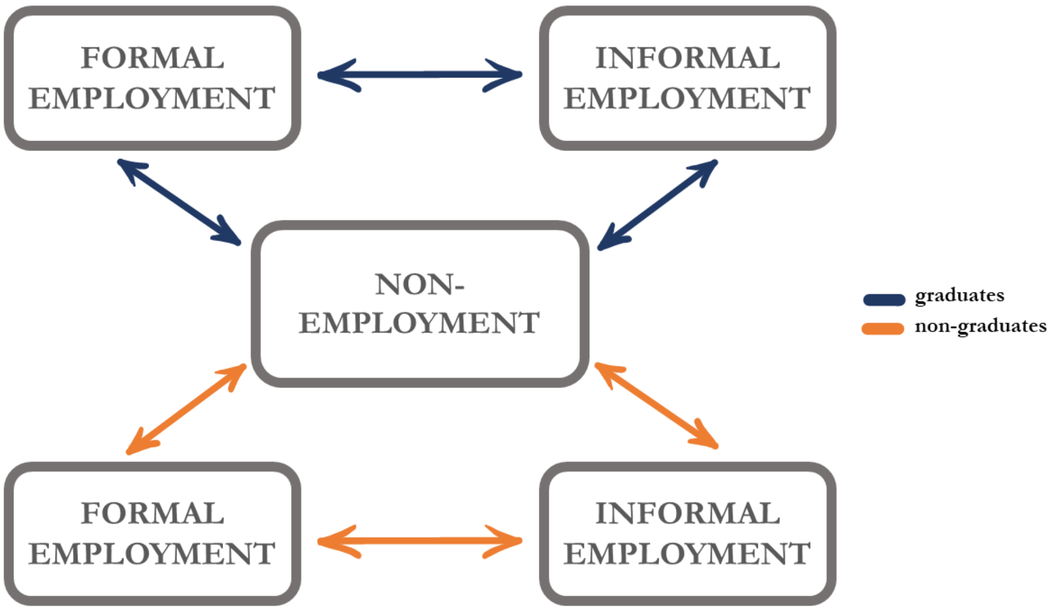

Figure 3: **The Dynamics of Graduate and Non-graduate Job Search**

3.1 The Labour Market

There are L^g graduates and L^{ng} non-graduates. In any period, ne_t^g graduates are not employed, $n_t^{g,I}$ graduates are employed by informal firms and $n_t^{g,F}$ are employed by formal firms, so

$$L^g = ne_t^g + n_t^{g,I} + n_t^{g,F} \tag{1}$$

Similarly, in any period, ne_t^{ng} non-graduates are not employed, $n_t^{ng,I}$ are employed by informal firms and $n_t^{ng,F}$ are employed by formal firms , so

$$L^{ng} = ne_t^{ng} + n_t^{ng,I} + n_t^{ng,F} \tag{2}$$

We summarise the labour market transitions for graduates and non-graduates in Fig. 3). We outline the labour market for graduates in formal firms but the labour markets for other jobs have the same structure, as outlined in the Online Appendix.

3.1.1 The Labour Market For Graduates in Formal Firms

Formal firms post $v_t^{g,F}$ vacancies for graduates. Search for these jobs comes from non-employed graduates and from graduates employed by informal firms, given by $s_t^{g,F} = \zeta^{g,\{NE,F\}} ne_t^g + \zeta^{g,\{I,F\}} n_t^{g,I}$, where $\zeta^{g,\{NE,F\}}$ and $\zeta^{g,\{I,F\}}$ are the intensities of search, by graduates not in employment and in informal firms, for jobs in formal firms. Defining tightness in the market for formal sector graduate jobs as $\theta_t^{g,F} = \frac{v_t^{g,F}}{s_t^{g,F}}$, hires are given by

$$h_t^{g,F} = m^{g,F} (\theta_t^{g,F})^{(1-\alpha^{g,F})} s_t^{g,F} \tag{3}$$

[11] Fernandez and Meza (2015) show that self-employment in Mexico correlates closely with measures of informal employment that assume there are informal firms; this suggests that modeling choices around this issue are not critical.

We assume that hires are proportional to search, so $h_t^{g,\{NE,F\}} = \frac{\zeta^{g,\{NE,F\}} ne_t^g}{s_t^{g,F}} h_t^{g,F}$ and $h_t^{g,\{I,F\}} = \frac{\zeta^{g,\{I,F\}} n_t^{g,I}}{s_t^{g,F}} h_t^{g,F}$.

Considering employment of graduates in the formal sector, job destruction occurs, at rate $\pi_t^{g,\{F,NE\}}$; so $\pi_t^{g,\{F,NE\}} n_t^{g,F}$ graduates leave formal sector employment and become non-employed. And $\pi_t^{g,\{F,I\}} n_t^{g,F}$ workers leave the formal sector for alternative jobs in the informal sector. Since $\pi_t^{g,\{F,F\}} + \pi^{g,\{F,NE\}} + \pi_t^{g,\{F,I\}} = 1$, employment of graduates in formal firms is therefore

$$n_{t+1}^{g,F} = \pi_{t+1}^{g,\{F,F\}} n_t^{g,F} + h_{t+1}^{g,F} \tag{4}$$

where $h^{g,F}$ is the number of graduates hired by formal firms. These hires come from non employed graduates and graduates employed by informal firms, so

$$h_t^{g,F} = h_t^{g,\{NE,F\}} + h_t^{g,\{I,F\}} \tag{5}$$

where $h_t^{g,\{NE,F\}}$ is the number of not employed graduates hired by formal firms and $h_t^{g,\{I,F\}}$ is the number of graduates hired from informal firms. There are given by $h_{t+1}^{g,\{NE,F\}} = \pi_{t+1}^{g,\{NE,F\}} ne_t^g$ and $h_{t+1}^{g,\{I,F\}} = \pi_{t+1}^{g,\{I,F\}} n_t^{g,I}$. We model the rate of job destruction as $\pi_t^{g,\{F,NE\}} = \pi^{g,\{F,NE\}} e^{\varepsilon_t^\tau}$; $\pi^{g,\{g,NE\}}$ is the steady-state rate of destruction of graduate formal jobs and ε_t^τ is a shock that captures the impact of the pandemic on the rate of job destruction.[12] The job finding and retention rates, ie $\pi_t^{g,\{F,F\}}$, $\pi_t^{g,\{I,F\}}$, $\pi_t^{g,\{NE,F\}}$ and $\pi_t^{g,\{I,F\}}$ are endogenously determined by our model.

3.2 Households

Household members collectively derive utility from consumption. The household utility function is

$$H_t = E_t \sum_{k=0}^{\infty} \beta e^{\varepsilon_{t+k}^d} \frac{C_{t+k}^{1-\eta}}{1-\eta} \tag{6}$$

where C is consumption and e^{ε^d} is a preference shock. The budget constraint of the household is

$$P_t \sum_{i\in\{I,F\}} \sum_{j\in\{I,F\}} w_t^{i,j} n_t^{i,j} + P_t b ne_t + B_{t-1} + \Pi_t - T_t = P_t C_t + q_t B_t \tag{7}$$

where $w^{g,F}$, $w^{ng,F}$, $w^{g,I}$ and $w^{ng,I}$ are respectively the wages of graduates in formal firms, non-graduates in formal firms, graduates in informal firms and non-graduates in informal firms; P is the consumption price index, $ne_t = ne_t^{ng} + ne_t^g$ is the number of non-employed workers, b is the real opportunity cost of employment and the value of home production[13] comprising the value of leisure and unemployment benefit, $q = \frac{1}{1+i}$ is the nominal price of bonds, Π is the profit the household receives for the ownership of firms and T_t is a lump-sum tax levied on the household by the government.

The household chooses consumption and bond purchases to maximise utility subject to their budget

[12] We assume that ε^τ is the same for all job matches since we are considering the same shocks hypothesis. It would be easy to allow for match-specific job destruction shocks in order to investigate the severe shocks hypothesis.

[13] There is no universal unemployment benefits system in Mexico. Apart from some limited cases (eg a 4 month program of support for some individuals in Mexico City who were previously employed in formal jobs), unemployed workers receive no state support.

constraint. The optimality condition for consumption and bonds gives the Euler equation

$$C_t^{-\eta} = \beta e^{\varepsilon_t^d} E_t C_{t+1}^{-\eta} \frac{1+i_t}{1+E_t\pi_{t+1}} \tag{8}$$

The real interest rate $r_t = \frac{1+i_t}{1+E_t\pi_{t+1}}$, so equation (8) implies that the stochastic discount factor is

$$E_t\beta_{t,t+1} = \beta e^{\varepsilon_t^d} \frac{E_t C_{t+1}^{-\eta}}{C_t^{-\eta}} \tag{9}$$

The household derives utility from consuming both formal and informal retail goods. We assume

$$C_t = \left[(\Gamma_t^F)^{\frac{1}{\nu}}(C_t^F)^{\frac{\nu-1}{\nu}} + (1-\Gamma_t^F)^{\frac{1}{\nu}}(C_t^I)^{\frac{\nu-1}{\nu}}\right]^{\frac{1}{\nu-1}} \tag{10}$$

where C^F is consumption of formal retail goods, C^I is consumption of informal retail goods and ν is the elasticity of substitution between them.[14] Γ_t^F is the proportion of household consumption that is of formal retail goods and $\Gamma_t^F = \Gamma^F e^{\varepsilon^{\Gamma_t^F}}$, where $\varepsilon^{\Gamma_t^F}$ is a shock to the preference for formal retail goods relative to informal retail goods. We use this shock in modelling the impact of the pandemic on the demand for different types of goods. The implied price index is

$$P_t = \left[\Gamma_t^F (P_t^F)^{1-\nu} + (1-\Gamma_t^F)(P_t^I)^{1-\nu}\right]^{\frac{1}{1-\nu}} \tag{11}$$

where P_t^F is the price index for formal retail goods and P_t^I is the price index for informal retail goods. The demand for formal and informal retail goods is

$$C_t^F = \Gamma_t^F \left(\frac{P_t^F}{P_t}\right)^{-\nu} C_t \tag{12}$$

and

$$C_t^I = (1-\Gamma_t^F)\left(\frac{P_t^I}{P_t}\right)^{-\nu} C_t \tag{13}$$

Household consumption of formal retail goods is a composite of individual formal retail goods defined by $C_t^F = (\int_0^1 (C_{jt}^F)^{\frac{\nu^F-1}{\nu^F}} dj)^{\frac{\nu^F}{\nu^F-1}}$, where C_j^F is household consumption of formal retail good j. The price index for formal retail goods is $P_t^F = (\int_0^1 (P_{jt}^F)^{(1-\nu^F)} dj)^{\frac{1}{1-\nu^F}}$ where P_j^F is the price of formal retail good j. Similarly, household consumption of informal retail goods is a composite of individual informal retail goods defined by $C_t^I = (\int_0^1 (C_{jt}^I)^{\frac{\nu^I-1}{\nu^I}} dj)^{\frac{\nu^I}{\nu^I-1}}$, where C_j^I is household consumption of informal retail good j. The corresponding price index is $P_t^I = (\int_0^1 (P_{jt}^I)^{(1-\nu^I)} dj)^{\frac{1}{1-\nu^I}}$ where P_j^I is the price of informal retail good j.

Households purchase formal retail good j from the retail firm in the formal retail sector that sells this good. Household demand is

$$C_{jt}^F = \left(\frac{P_{jt}^F}{P_t^F}\right)^{-\nu^F} C_t^F \tag{14}$$

Similarly, households purchase informal retail good j from the retail firm in the informal retail sector that

[14] Informal goods are often substitutes for formal sector goods. For example, informal street markets offer similar goods and services to formal sector shops. And outlets selling informal street food have similarities with formal restaurants.

sells this good. Household demand for this good is

$$C^I_{jt} = \Big(\frac{P^I_{jt}}{P^I_t}\Big)^{-\nu^I} C^I_t \tag{15}$$

3.3 The Government, the Central Bank and Aggregate Demand

Aggregate demand is the sum of demand from households and the Government.

$$Y_t = C_t + G_t \tag{16}$$

Government demand for output is the sum of the demand for formal and informal retail goods, so

$$G_t = G^F_t + G^I_t \tag{17}$$

We assume that government expenditure does not distort the pattern of aggregate demand[15], so $\frac{G^F_t}{G_t} = \frac{C^F_t}{C_t}$.

We assume that the Central Bank sets the interest rate using the simple Taylor rule

$$i_t = \bar{i} + \phi_\pi \pi_t + \phi_y \hat{y}_t + \varepsilon^i_t \tag{18}$$

where $\hat{y}$ is the output gap and ε^i_t is a monetary policy shock.

3.4 Wholesale Firms

We will outline the environment and decisions of formal sector firms. The analysis for informal firms is similar, as outlined in the Online Appendix.

3.4.1 Formal Wholesale Firms

All formal wholesale firms are competitive and identical. There is no rigidity in wholesale prices, so all formal wholesale firms set the same price. The objective function of the representative formal wholesale firm is

$$J^F_t = E_t \sum_{k=0}^{\infty} \frac{\beta^{t+k}\Lambda_{t+k}}{\Lambda_t} \Big\{ \frac{P^{F,W}_t}{P^F_t} Y^{W,F}_{t+k} - w^{g,F}_{t+k} n^{g,F}_{t+k} - w^{ng,F}_{t+k} n^{ng,F}_{t+k} - \gamma^{g,F} v^{g,F}_t - \gamma^{ng,F} v^{ng,F}_t \Big\} \tag{19}$$

where $Y^{W,F}$ is output, $P^{F,W}$ is the price of the output of formal wholesale firms, P^F is the price of the output of formal retail firms, $\gamma^{g,F}$ is the cost of posting a vacancy for a graduate and $\gamma^{ng,F}$ is the cost of posting a vacancy for a non-graduate.

Based on evidence in the Online Appendix that graduates and non-graduates do different tasks in formal firms, we express the production function as

$$Y^{W,F}_t = A^{g,F}_t n^{g,F}_t + A^{ng,F}_t n^{ng,F}_t \tag{20}$$

where $A^{g,F}_t = A^{g,F} e^{\varepsilon^s_t}$, $A^{ng,F}_t = A^{ng,F} e^{\varepsilon^s_t}$ and ε^s_t is a shock to the productivity of workers; this will capture the impact of the pandemic on productivity.[16] The formal firm chooses the number of vacancies for graduates

[15] We subsume the impact of a government demand shock into the aggregate demand shock.

[16] As with job destruction shocks, we assume ε^s is the same for all workers since we will simulate this model under the same shocks hypothesis; it would be easy to allow for different productivity shocks for different types of worker.

to post to maximise (19) subject to (20) and (4). The optimality condition is

$$\frac{\partial J_{t+1}^{F}}{\partial v_t^{g,F}} = -\gamma^{g,F} + E_t\beta_{t,t+1}q_{t+1}^{g,F}\frac{\partial J_{t+1}^{F}}{\partial n_{t+1}^{g,F}} = 0 \tag{21}$$

where $\frac{\partial J_t^F}{\partial n_t^{g,F}} = \frac{A_t^{g,F}}{\mu^F} - w_t^S + E_t\pi_{t+1}^{g,\{F,F\}}\beta_{t,t+1}\frac{\partial J_{t+1}^F}{\partial n_{t+1}^{g,F}}$ and where $\mu^F = \frac{P_t^F}{P_t^{F,W}}$. Noting that (21) implies $\frac{\partial J_{t+1}^F}{\partial n_{t+1}^{g,F}} = \frac{\gamma^h}{E_t q_{t+1}^{g,F}}$, and so $\frac{\partial J_t^F}{\partial n_t^{g,F}} = \frac{A_t^{g,F}}{\mu^F} - w_t^{g,F} + E_t\pi_{t+1}^{g,\{F,F\}}\beta_{t,t+1}\frac{\gamma^{g,F}}{q_{t+1}^{g,F}}$, the optimality condition implies

$$\frac{A_t^{g,F}}{\mu^F} = w_t^{g,F} + \lambda_t^{g,F} \tag{22}$$

where $\lambda_t^{g,F} = \gamma^{g,F}(\frac{1}{q_t^{g,F}} - E_t\pi_{t+1}^{g,\{F,F\}}\beta_{t,t+1}\frac{1}{q_{t+1}^{g,F}})$ is the marginal cost of hiring a graduate for a formal firm. Using similar arguments, the optimality condition for non-graduates at formal firms is

$$\frac{A_t^{ng,F}}{\mu^F} = w_t^{ng,F} + \lambda_t^{ng,F} \tag{23}$$

where $\lambda_t^{ng,F} = \gamma^{ng,F}(\frac{1}{q_t^{ng,F}} - E_t\pi_{t+1}^{ng,\{F,F\}}\beta_{t,t+1}\frac{1}{q_{t+1}^{ng,F}})$ is the marginal cost of hiring a non-graduate for a formal firm.

3.5 Wage Determination

We assume that wage bargaining takes place between firms and individual workers. We incorporate real wage rigidity, which we model following Krause and Lubik (2007) and Faia (2008). We outline wage determination for graduates in formal firms.[17] This wage is given by

$$w_t^{g,F} = \{\varphi^{g,F}w^{g,F} + (1-\varphi^{g,F})w_t^{b\{g,F\}}\} \tag{24}$$

where $w_t^{b,\{g,F\}}$ is the wage implied by bargaining, $w^{g,F}$ is the steady-state value of this wage, $\varphi^{G,F}$ captures real wage rigidity. Since graduates can work in both formal and informal sectors, $w^{b\{g,F\}}$ will depend on conditions in the informal sector. Wage bargaining for graduates in both sectors is determined by the sharing rules

$$(1-\vartheta^{g,F})S_t^{g,F} = \vartheta^{g,F}F_t^{g,F} \tag{25}$$

and

$$(1-\vartheta^{g,I})S_t^{g,I} = \vartheta^{g,I}F_t^{g,I} \tag{26}$$

where $S_t^{g,F}$ and $S_t^{g,I}$ are is the surpluses to the household from an additional graduate being employed in a formal and an informal firm, respectively, $F_t^{g,F}$ and $F_t^{g,I}$ are the respective surpluses to firms and $\vartheta^{g,F}$ and $\vartheta^{g,I}$ are the respective bargaining powers.

The formal firm's surplus from the wage bargain is $F_t^{g,F} = \frac{\partial J_t^F}{\partial n_t^{g,F}}$. Because of the assumption of constant returns, we can combine this with the optimality condition for formal firms to obtain

$$F_t^{g,F} = \frac{P_t^{F,W}}{P_t^F}A_t^{g,F} - w_t^{b\{g,F\}} + E_t\beta_{t,t+1}\pi_{t+1}^{g,\{F,F\}}\frac{\gamma^F}{q_{t+1}^{f,F}} \tag{27}$$

[17]Details of this, and wage determination for other types of job match, are contained in the Online Appendix.

and

$$E_t F^{g,F}_{t+1} = E_t \frac{\gamma^{g,F}}{q^{g,F}_{t+1}} \tag{28}$$

We can express household utility as

$$V^H_t = \frac{C^{1-\eta}_{t+k}}{1-\eta} + E_t \beta_t V^H_{t+1} \tag{29}$$

where $\beta_t = \beta e^{\varepsilon^d_{t+1}}$. The surplus the household derives from successful conclusion of the graduate formal sector wage bargain is $S^{g,F}_t = \frac{1}{C_t^{-\eta}}(\frac{\partial V^H_t}{\partial n^{g,F}_t} - \frac{\partial V^H_t}{\partial u^g_t})$ and the surplus from successful conclusion of the graduate informal wage bargain is $S^{g,I}_t = \frac{1}{C_t^{-\eta}}(\frac{\partial V^H_t}{\partial n^{g,I}_t} - \frac{\partial V^H_t}{\partial u^g_t})$.

From these, we can express the bargained wage for graduates in formal sector firms as

$$w^{g,I}_t = \eta^{g,F}\{\frac{P^W_t}{P_t} A^{g,F}_t + \zeta^{g,\{NE,F\}}\gamma^{g,F} E_t \beta_{t,t+1}\theta^{g,F}_{t+1}\} + \tilde{\eta}^{g,I}\gamma^{g,I} E_t \beta_{t,t+1}\theta^{g,I}_{t+1} + (1-\eta^{g,F})b \tag{30}$$

where $\tilde{\eta}^{g,I} = \eta^{g,I}(\frac{1-\eta^{g,F}}{1-\eta^{g,I}})(\zeta^{g,\{F,I\}} - \zeta^{g,\{NE,I\}})$.

The real wage for formal sector graduates depends on their marginal product $(\frac{P^{F,W}_t}{P^F_t} A^{g,F}_t)$ and the marginal cost of hiring replacement workers (proportional to $\gamma^{g,F}\theta^{g,F}_{t+1}$). It also depends on the cost of hiring graduates in informal firms (proportional to $\gamma^{g,I}\theta^{g,I}_{t+1}$). This latter effect arises because the value to the household of an additional employed graduate, rather than an additional not employed graduate, depends on the impact this hire has on the probability that this worker is employed in the informal sector in the next period.

3.6 Retail Firms

There is a continuum of identical formal sector retail firms, with production function

$$Y^F_t = Y^{W,F}_t \tag{31}$$

where $Y^{W,F}$ are purchases of formal sector wholesale goods. Formal sector retail firms re-optimise price with probability $(1-\omega^F)$; firms that do not re-optimise increase price by a proportion $\varphi^{\pi,F}$ of the previous sectoral inflation rate. The informal retail sector is similar. There is a continuum of identical informal sector retail firms, with production function

$$Y^I_t = Y^{W,I}_t \tag{32}$$

In this sector, retail firms re-optimise price with probability $(1-\omega^I)$; firms that do not re-optimise increase price by a proportion $\varphi^{\pi,I}$ of the previous sectoral inflation rate.

4 Calibration

We will analyse the impact of the pandemic in Mexico by simulating our model around its steady-state, using a series of shocks that are designed to mimic the Mexican pandemic. Since the impact of the pandemic on the Mexican labour market and economy was so large, we can assume that Mexico was close to steady-state in the periods immediately before the onset of the crisis. As a result, we treat the values in Figure 1) and Table 1) as steady-state values. Based on Figure 1), we set $n^{g,F} = 0.123$, $n^{g,I} = 0.076$, $ne^g = 0.104$, $n^{ng,F} =$

0.105, $n^{ng,I} = 0.234$ and $ne^{ng} = 0.359$ as calibration targets. From Table 1), we have $\pi^{g,\{F,NE\}} = 0.076$, $\pi^{g,\{I,NE\}} = 0.194$, $\pi^{ng,\{F,NE\}} = 0.097$ and $\pi^{ng,\{I,NE\}} = 0.210$ as calibration targets for the rates of job destruction. And we use $\pi^{g,\{F,F\}} = 0.810$, $\pi^{g,\{I,I\}} = 0.600$, $\pi^{ng,\{F,F\}} = 0.702$ and $\pi^{ng,\{I,I\}} = 0.702$ as calibration targets for the rates of job retention. Our calibration targets for graduate job finding rates are $\pi^{g,\{NE,F\}} = 0.095$, $\pi^{g,\{I,F\}} = 0.206$, $\pi^{g,\{NE,I\}} = 0.149$ and $\pi^{g,\{F,I\}} = 0.114$, while for non-graduates, they are $\pi^{ng,\{NE,F\}} = 0.028$, $\pi^{ng,\{I,F\}} = 0.088$, $\pi^{ng,\{NE,I\}} = 0.146$ and $\pi^{ng,\{F,I\}} = 0.201$.

These values give implied steady-state values of hiring flows. For example, hiring of graduates by formal sector firms from non-employment is $h^{g,\{NE,F\}} = \pi^{g,\{NE,F\}} ne^{g} = 0.0099$. This and other steady-state hires give us a further set of calibration targets, which are documented in Table 2). For graduates, most hires by formal sector firms come from workers employed in the informal sector rather than from the non-employed. For informal firms, hires from the formal sector and from the non-employed are roughly equal. For non-graduates, the majority of hires by formal firms come from the informal sector, whereas most hires by informal firms comes from the non-employed.

Table 2: **Calibration Targets For Labour Market Hires and Search in Mexico**
% of workforce

i) Graduates	Formal Firms	Informal Firms
Formal Firms	—	$h^{g,\{F,I\}} = 0.0140$
	—	$s^{g,\{F,I\}} = 0.0230$
Informal Firms	$h^{g,\{I,F\}} = 0.0157$	—
	$s^{g,\{I,F\}} = 0.0525$	—
Non Employment	$h^{g,\{NE,F\}} = 0.0099$	$h^{g,\{NE,I\}} = 0.0155$
	$s^{g,\{NE,F\}} = 0.0832$	$s^{g,\{NE,I\}} = 0.0208$

ii) Non-Graduates	Formal Firms	Informal Firms
Formal Firms	—	$h^{ng,\{F,I\}} = 0.0211$
	—	$s^{ng,\{F,I\}} = 0.0361$
Informal Firms	$h^{ng,\{I,F\}} = 0.0206$	—
	$s^{ng,\{I,F\}} = 0.5516$	—
Non-Employment	$h^{ng,\{NE,F\}} = 0.0101$	$h^{ng,\{NE,I\}} = 0.0524$
	$s^{ng,\{NE,F\}} = 0.2693$	$s^{ng,\{NE,I\}} = 0.0898$

The next step is to determine job search. We calibrate the search effort of non-employed graduates as $\zeta^{g,\{NE,F\}} = 0.800$. Since hiring rates of different groups are proportional to relative search intensities, then $\frac{h^{g,\{NE,F\}}}{h^{g,iF}} = \frac{s^{g,\{NE,F\}}}{s^{g,IF}} = \frac{\zeta^{g,\{NE,F\}} ne^{g}}{\zeta^{g,\{IF\}} n^{g,I}}$. This implies that we can calibrate the search intensity of graduates in informal firms as $\zeta^{g,\{IF\}} = \frac{\zeta^{g,\{NE,F\}} u^{g}}{n^{g,I}} \frac{h^{g,IF}}{h^{g,NE,F}} = 0.691$. Non-employed workers search for jobs in formal and informal firms. We normalise search effort by assuming $\zeta^{g,\{NE,F\}} + \zeta^{g,\{NE,I\}} = 1$ and $\zeta^{ng,\{NE,F\}} + \zeta^{ng,\{NE,I\}} = 1$. For graduates, this implies $\zeta^{g,\{NE,I\}} = 0.2$, which in turn implies $\zeta^{g,\{FI\}} = \frac{\zeta^{g,\{NE,I\}} u^{g}}{n^{g,F}} \frac{h^{g,FI}}{h^{g,\{NE,I\}}} = 0.187$. We calibrate the search intensity of not employed non-graduates for employment in the formal sector as $\zeta^{ng,\{NE,F\}} = 0.75$. Following similar arguments to above, this implies $\zeta^{ng,\{NE,I\}} = 0.25$, $\zeta^{ng,\{I,F\}} = 2.357$ and $\zeta^{ng,\{F,I\}} = 0.344$. These calibrated search intensities imply calibration targets for the levels of job search; these are also documented in Table 2). We note that for graduates, search by workers in informal jobs for formal sector jobs is more than double the search of workers in formal jobs for informal jobs; and the search of unemployed graduates for formal sectors jobs is four times larger than their search for informal jobs. The pattern of search for non-graduates is similar.

We next calibrate values for the matching elasticities (α), the mark-up for formal and informal sectors

(μ), relative bargaining power (φ), steady-state productivity (A) and the cost of posting a vacancy (γ) as detailed in Table 3). We also set the real opportunity cost of employment and the value of home production and leisure as $b = 0.4$ and the discount factor as $\beta = 0.995$. We then solve for the values of the wage (w), labour market tightness (θ), the marginal cost of hiring (λ) and the efficiency of job matching (m), for each type of job match, that ensure our calibration targets are met, while also satisfying the matching functions (e.g. (3)) and the optimality conditions (e.g. (22)). To illustrate this for the labour market for graduates in the formal sector, we calibrate $\alpha^{g,F} = 0.5$, $A^{g,F} = 1.3$, $\mu^F = 1.1$, $\eta^{g,F} = 0.5$ and $\gamma^{g,F} = 0.25$. We obtain $\theta^{g,F} = 0.819$, $w^{g,F} = 0.951$, $\lambda^{g,F} = 0.231$ and $m^{g,F} = 0.208$. From Table 3), we note that the wage premium for graduates over non-graduates is higher in formal jobs, that the labour market for informal jobs is tighter than that for formal jobs, implying that workers can find employment in the informal sector more easily and that job matching is more efficient for informal jobs. Table 3) also documents the implied value of the surplus from each type of job match.[18] We find that the surplus for graduates is higher than that of non-graduates, especially in formal jobs. This confirms our assertion that the surplus from employing non-graduates is low; such job matches are therefore more fragile than job matches with graduates, consistent with Table 1).

Table 3: **Implied Steady-State Tightness, Wages and Hiring Costs in Mexico**

	α	A	μ	φ	γ	θ	w	λ	m	J
i) Graduates										
Formal Firms	0.5	1.3	1.1	0.5	0.25	0.819	0.951	0.231	0.208	1.094
Informal Firms	0.5	0.7	1.1	0.2	0.1	2.312	0.502	0.135	0.444	0.345
i) Non-Graduates										
Formal Firms	0.5	0.6	1.1	0.3	0.15	0.068	0.465	0.081	0.144	0.273
Informal Firms	0.5	0.5	1.1	0.1	0.05	1.329	0.419	0.036	0.507	0.114

5 Modelling the Pandemic

5.1 Modelling the Pandemic

We model the impact of the Covid-19 pandemic as a series of deterministic simultaneous shocks. To model the impact of these, we write the linearised representation of our model as[19]

$$A_0 E_0 X_{k+1} = A_1 X_k + A_2 X_{k-1} + B\varepsilon_k^{pan} \tag{33}$$

for $k = 1, 2, 3...$, where X_k is a $(n \times 1)$ vector containing the n endogenous variables of the model at time k; ε_k^{pan} is a $(s \times 1)$ vector containing the s shocks that we use to represent the pandemic; A_0, A_1 and A_2 are $(n \times n)$ matrices and B is a $(n \times s)$ matrix; these contain structural parameters of the model, calibrated as described in the previous section. In our model, $n = 85$ and $s = 5$. We proceed by choosing values for the shocks in ε^{pan} so that simulated values for the four types of employment and for output match the data. An alternative methodology, used by Leyva and Urrutia (2021), would be to use the data to back out the implied

[18]For example, the surplus for graduates employed in formal jobs is $J^{g,F} = \frac{\gamma^{g,F}}{E_t \beta q^{g,F}}$.

[19]Our model contains over 60, often highly nonlinear equations. It can be solved and simulated without linearisation; but we found that solutions were sensitive to small changes in the specification of the model. This was an issue when exploring the scenarios outlined below. After some experimentation, we chose to simulate a linearised version of our model, as this gave more robust results.

shocks from the calibrated model. In practice, these approaches are similar.[20] We assume the pandemic began in 2020Q2, when $k = 1$; we assume the Mexican economy was in steady-state (relative to the major disruption that followed) in 2020Q1. We use a deterministic simulation of the model, showing the response of the endogenous variables to the shocks in ε^{pan}. We model the shocks after this date as autoregressive processes, so

$$\varepsilon_k^z = \rho^z \varepsilon_{k-1}^z \tag{34}$$

for $k > 1$, where z indexes the shock; so the behaviour of the shock over time is characterised by the incidence in 2020Q2 and the persistence parameter.

Our calibrated shocks are documented in Table 4). Our model contains shocks to aggregate demand (ε^d), to monetary policy (ε^i), to the relative demand for formal and informal goods (ε^{Γ^F}), to productivity (ε^s) and to job destruction (ε^τ).[21] We calibrate ε^d to give a 9.5% reduction in aggregate demand in 2020Q2. We mimic the response of the Central Bank of Mexico to the pandemic by calibrating an initial 85bp decline in the policy rate, followed by further cuts of 100bp and 115bp, giving a total of 300bp, in subsequent quarters. We also calibrate ε^{Γ^F} to give a 5% reduction in the relative demand for retail formal goods at the onset of the pandemic; for example, as a result of households switching expenditure away from informal sources such as street food and open-air markets towards restaurants in the formal sector offering takeaway and delivery services.[22] Our calibration of supply shocks reflects data on the impact of the Covid-19 pandemic on productivity via workers being away from the workplace. We denote the proportion of workers who were away from the workplace and not working as ϕ_t^{abs} and the proportion working from home as ϕ_t^{wfh}. These latter contribute to production, but are less productive than those who continue at the workplace; the relative productivity of working from home is denoted as ω_t^{wfh}. This implies that the supply shock during the pandemic is $e^{\varepsilon_t^s} = e^{(1-\phi_t^{abs}-\phi_t^{wfh}\omega_t^{wfh})}$. We calibrate ε^s to give a 12% reduction in productivity at the onset of the pandemic and calibrate ε^τ to give a 60% increase in job destruction.

Table 4: Calibrated Shocks

Shock	Variable	Change in Variable	Persistence of Shock
ε^d	Aggregate Demand	$\downarrow$ 9.5%	0.86
ϵ^i	Monetary Policy	$\downarrow$ 85 b.p	0.86
ε^{Γ^F}	Relative Demand for Formal Goods	$\downarrow$ 5%	0.86
ε^s	Productivity	$\downarrow$ 12%	0.40
ε^τ	Job Destruction	$\downarrow$ 60%	0.40

5.2 Simulation Results

The results of our simulations are shown in Figure 4). The top-left hand panel plots actual and simulated values for employment of graduates and non-graduates. Even though all workers are hit by the same shocks, our model is able to replicate the much larger fall in non-graduate employment, capturing the impact of the

[20] Our approach ensures that our model matches the data on employment and output, as these variables are central to our research questions. We give less priority to matching movements in other variables during the pandemic, but will return to this in future work.

[21] Reflecting differences in the model they use, Leyva and Urrutia (2021) analyse the pandemic using a different set of shocks: they use shocks to the disutility of working, to the foreign interest rate, and use productivity shocks for the formal and informal sectors. They do not use aggregate demand or monetary policy shocks as their model assumes price flexibility.

[22] ILO (2020a) and ILO (2020b) document the especially severe impact of the pandemic on street vendors and other traders without a fixed location.

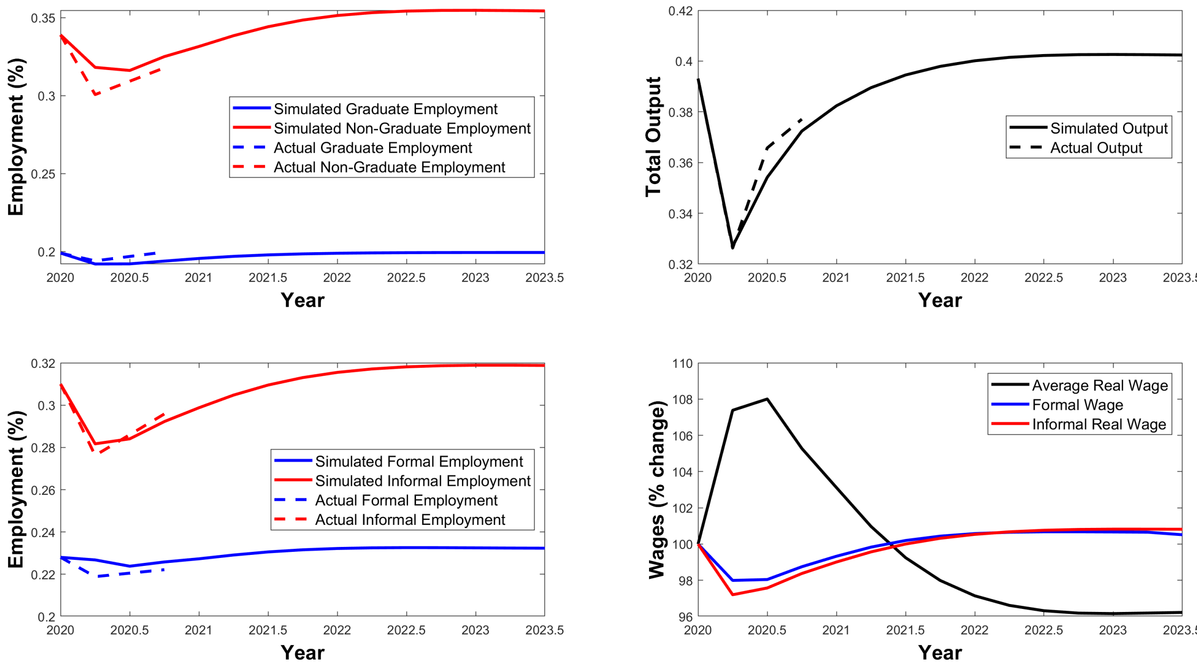

Figure 4: The Baseline Model

larger reductions in hiring and larger increases in job separation for these workers which result from smaller surpluses from job matches with non-graduates. The bottom-left hand panel plots actual and simulated values for employment of formal and informal workers. The simulated model is able to replicate the larger fall in employment of informal workers in response to shocks that are the same for all workers, again because the surplus from a job match is smaller for informal workers. These results show that the differential impacts of the Covid-19 pandemic on different types of workers are caused by structural inequalities in the Mexican labour market.

The upper-right panel plots the simulated values of output against actual outcomes; here, the model is able to capture the very steep fall in output in 2020Q2 and the subsequent recovery. The bottom right panel of the Figure plots the simulated value for the real wage. There is strong composition effect that implies a rise in the aggregate real wage even though wages in the formal and informal sectors are suppressed. This effect is present in the data, but this occurs 1-2 quarters later than in our simulations. This is probably because of the impact of features such as the minimum wage system and other aspects of wage determination that are not captured in our model.

6 Conclusions

This paper has analysed the differing impacts of the Covid-19 pandemic on the labour market in Mexico. We have highlighted how the crisis exacerbated structural differences in the Mexican labour market that impact disproportionately on non-graduates and those working in informal jobs. These structural differences are manifested in systematic differences in rates of hiring from non-employment and transitions from employment into non-employment between graduates and non-graduates and formal compared to informal workers. To explain these findings, we have built a DGSE model that differentiates between graduates and non-graduates as well as between formal and informal workers. The key feature of our model is that non-graduates and informal workers are more likely to be employed in jobs that generate a smaller surplus. This enables our model to explain the shorter job tenures and much higher rates of transition from employment to non-employment for non-graduates compared to graduates. We simulate this model using shocks that are designed to replicate the impact of the pandemic under the assumption that all workers are hit by the same shocks. The small surplus for job matches with non-graduates and formal workers makes these matches more likely to break down in response to shocks than matches with other types of workers; this is the mechanism through which simulations of our model are able to match the larger impacts of the pandemic on non-graduates and informal workers.

Our results show that extending a standard DSGE model with labour market frictions to reflect the different experiences of different workers can give useful insights into the impact of the pandemic in an economy like that of Mexico, and can be useful for policy evaluation. However, there are some caveats. There is no uncertainty in our model. We assume the pandemic does not affect the steady-state or change structural relationships. And we use a linearisation of the model even though the pandemic moves the economy some distance away from the steady-state. Given the unprecedented scale and nature of the crisis, it is important that the impact of the pandemic on the labour market is also analysed using alternative models and approaches.

Our model and findings are likely to have relevance beyond the case of Mexico. The importance of informal employment, mainly of non-graduates, has been widely documented, accounting for 55% of employment in upper-middle income countries, such as Mexico, and for 85% of employment on average in lower-middle income countries (ILO, 2020*a*). As discussed by Furceri et al. (2020) and ILO (2020*b*), the impact of the Covid-19 pandemic has been especially severe on these types of jobs. Our model may be useful in explaining the differing impacts of Covid-19 in these types of countries; we intend to address this in future work.

References

Alberola, E. and Urrutia, C. (2020), 'Does Informality Facilitate Inflation Stability?', *Journal of Development Economics* **146**.

Arceo-Gomez, E. and Campos-Vazquez, R. (2010), Labor supply of married women in mexico: 1990-2000, Technical report, El Colegio de México, Centro de Estudios Económicos.

Colombo, C., Menna, L. and Tirelli, P. (2019), 'Informality and the Labor Market Effects of Financial Crises', *World Development* **119**, 1–22.

Dix-Carneiro, R., Goldberg, P., Meghir, C. and Ulyssea, G. (2021), 'Trade and Informality in the Presence of Labor Market Frictions and Regulations', *Yale University* .

Faia, E. (2008), 'Optimal Monetary Policy Rules with Labor Market Frictions', *Journal of Economic Dynamics and Control, 32, 5, 1600-1621* (32), 1600–1621.

Fernandez, A. and Meza, F. (2015), 'Informal Employment and Business Cycles in Emerging Economies: The Case of Mexico', *Review of Economic Dynamics* **18**, 381–405.

Furceri, D., Loungani, P., Ostry, J. D. and Pizzuto, P. (2020), '13 pandemics and inequality: Assessing the impact of covid-191', *COVID-19 in developing economies* p. 200.

Horvath, J. (2018), 'Business Cycles, Informal Economy, and Interest Rates in Emerging Countries', *Journal of Macroeconomics* **55**(C), 96–116.

ILO (2020*a*), 'Ilo monitor: Covid-19 and the world of work'.

ILO (2020*b*), 'Impact of lockdown measures on the informal economy', *ILO Brief* pp. 1–16.

Krause, M. and Lubik, T. (2007), 'The (Ir)relevance of Real Wage Rigidity in the New Keynesian Model with Search Frictions', *Journal of Monetary Economics* (54), 706–727.

La Porter, R. and Shliefer, A. (2008), 'The unofficial economy and economic development', *Bookings Papers on Economic Activity* **39**(2), 275–363.

Leyva, G. and Urrutia, C. (2020), 'Informality, Labor Regulation, and the Business Cycle', *Journal of International Economics* **126**, 103340.

Leyva, G. and Urrutia, C. (2021), 'Informal labor markets in times of pandemic: Evidence for latin america and policy options'.

OECD (2019), 'Tackiling Vulnerability in the Informality Economy', *OECD Publications* .

Restrepo-Echavarria, P. (2014), 'Macroeconomic Volatility: The Role of the Informal Economy', *European Economic Review* **70**, 454–469.

Vargas, A. S., Merino, A. L. H. and Hernández, I. P. (2015), 'La participación laboral femenina y el uso del tiempo en el cuidado del hogar en méxico', *Contaduría y administración* **60**(3), 651–662.